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THE TELEGRAPHIC JOURNAL AND

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PROSPECTS OF SUBMARINE TELEGRAPHY.

USUALLY when traffic receipts and incomes generally are decreasing and directors have to meet their shareholders with recommendations of lowered dividends, the signs of depression are regarded as the reverse of encouraging. Notwithstanding, however, that at the present moment symptoms of failing revenues are more widespread than ever, stockholders in telegraph companies are displaying a marvellous amount of patience, and appear strangely infatuated with the idea that there is a glimmering of hope before them. This is to their credit; but it is remarkable, for in the past they have been amongst the most clamorous when all has not seemed to go well. This is the season when the too often hostile parties, the directors and the shareholders, come together for purposes of mutual congratulation or condolence, or, as unhappily is some times the case, for mutual abuse. To one who has been accustomed to peruse the accounts of these meetings, a notable feature in this year's proceedings must be the strong contrast between the tolerant and even encouraging spirit now manifested towards the directors in many instances and the spirit of rancour which formerly was so conspicuous. At a period when active competition is proceeding in the Atlantic, and when other serious dangers have to be faced, it is scarcely seemly to fritter away time and energy in bandying heated words across the baize; this seems to have been generally recognised, and the tone of recent meetings has benefited thereby.

Another commendable sign is the reasonable style in which the chairmen of the Direct United States and the Anglo-American Companies now speak of their antagonists, Messrs. Mackay and Bennett. They have come at last to admit that the bottom of the Atlantic is not their exclusive property, and that if another body can, independently of the amalgamated companies, conduct a telegraphic business upon a commercial basis it should not be blamed for making the attempt. No balance sheet of the Commercial Cable Company has been made public, but the joint companies evidently believed that the interloper was making a tolerably good thing out of its lower rate, or they would not have resolved upon the seemingly desperate expedient of adopting a rate of 6d. per word when even a 2s. rate had been shown to be only slightly remunerative. An increase in the number of messages of considerably over 100 per cent. in the course of a few months seems to justify very sanguine hopes, and we heartily desire to see those hopes borne out. At the same time we cannot refrain from expressing our opinion that before a satisfactory return can be obtained some years must elapse. Still, we are firmly convinced that Mr. Pender is right when he says, "Telegraphy must grow," and we can only commend patience to the shareholders.

THE EDISON FILAMENT CASE.

By JAS. SWINBURNE.

THE enormous importance of the decision in the recent lamp case is gradually coming to be understood by the public. Before, and even just after the trial people seemed to think it was a comparatively small matter, concerning Messrs. Woodhouse and Rawson only; but now they are beginning to see what it may mean to allow the monopoly of incandescent lighting to fall into the hands of one company.

Presumably, Messrs. Woodhouse and Rawson are going to appeal; and it looks as if the Anglo-American Brush Corporation does not intend the Edison-Swan Company to ride rough-shod over them. As more litigation is thus to be expected a full discussion of the Edison case may be advisable.

As many may know that I am now Messrs. Crompton's scientific manager, I must point out that I am writing entirely on my own responsibility as an old maker of incandescent lamps, and not in any way as one of Messrs. Crompton's staff.

The first thing that strikes one is the extraordinary weakness of the defendants in the matter of expert evidence. The plaintiffs, having a doubtful case, naturally had resource to the best "scientific witnesses" they could get, as they could not well get people who understood incandescent lamps to hold the opinions they wanted. The defendants had no witnesses who could contradict them. The case was almost a *reductio ad absurdum* of the expert farce. Probably not one of the witnesses had ever made a lamp himself, or had ever had to do with their manufacture. A great deal has been written lately about expert witnesses. The expert is simply a witness with a sufficiently well-known name for his opinion to carry weight with the judge. The best witness is he who works best with his counsel in persuading the judge to take one or other view. Witnessing is a sort of art in itself, and many men are known as "good witnesses" and make quite an income from this source. To be a good witness it is not necessary to know anything about the subject in question, in fact such knowledge may be a disadvantage, for without it he is more likely to be able to take the views required by his side. It is, of course, impossible even for a witness of undoubted integrity to be impartial.

When a large company wishes to attack a small one, the first thing done is to retain not only the counsel that are wanted to appear, but, it is said, to retain as many of the leading men as possible, at nominal fees, so as to prevent their appearing on the other side. Witnesses are treated the same way. The less powerful litigants must thus appear with less eminent counsel, and, perhaps, are not allowed to secure any counsel at all who have had much experience in patent cases. They are also deprived of the assistance of all the big witnesses.

The only evidence admissible in an incandescent lamp case should have been that of experts in incandescent lamps. No one would dream of denying the position of the witnesses in the scientific world, or of not admitting their authority on any subjects they have specially studied, but the collective opinions of the whole of them on incandescent lamps can carry no more weight than Irving's or Ruskin's writings on America or Economics.

On reading Edison's specification, No. 4,576, 1879, we find first that his object is to make lamps that can be used in parallel. He does not claim to have invented incandescent lamps, or to have made them possible; he merely aims at making them of high enough resistance to work in parallel. It was well known at that date that such lamps should have high resistance, and it was well known that carbon could be used for incandescent lamps, and that a long and thin piece of a conductor had a high resistance compared with a short thick piece. It was also known that an incandescent lamp should have as good a vacuum as possible, and should preferably be made of glass with leading-

in wires of platinum. The great difficulty was to secure a good enough vacuum to make the carbon durable. A short thick carbon was more durable with a bad vacuum, and so until a better vacuum could be obtained very thin carbons were useless. To make a commercial parallel lamp Edison had, therefore, to make a long thin conductor of a durable substance, and a vacuum good enough for it to last in. The materials known were refractory metals and carbon pure or mixed with earthy matters; and it was known that long thin pieces of either material could be made. Edison rejected the metal and chose carbon either pure or mixed with earthy matters. Edison also had to find a good way of fixing the carbon to the platinum. He says that, heretofore, lamps have had rods of from one to four ohms resistance in inert gases in vessels with metallic bases. He was, of course, wrong; vessels wholly of glass were already well known for lamps of high resistance and low resistance, though the former had metal conductors.

The connection between the carbon and leading-in wires by means of more bulky carbon was also known. He goes on to say low resistance lamps cannot be made with platinum leading-in wires and a glass vessel. He is again wrong; a platinum wire carrying 12 ampères can be sealed into glass without enamel. Edison gives no instructions as to how to make his carbons. He lapses into anecdote and says he has "discovered" that a carbonised thread is absolutely stable at very high temperatures. This is, of course, nonsense. A plain carbonised thread would not do for a carbon; though it would make a comparatively good lamp if treated according to methods then well known, but not mentioned by Edison, and put in a good vacuum. The discoverer goes on to tell how any fibrous vegetable substance will do. Here resort must be made to experiment, for there are very few fibrous materials that will make a lamp that would be good even with the most approved modern methods of treatment. Edison goes on to describe a mixture of lampblack and tar with camphor or oxide of zinc. It is not clear, therefore, whether this is to be used or not. If a commercial lamp cannot be made with a high resistance conductor of lampblack, tar, and camphor or oxide of zinc, the patent is void. It is very strange that the defendants did not insist on the insufficiency of the description and the impracticability of Edison's lamp. Edison says all his forms of conductor are so fragile that they cannot be clamped to the leading wires with sufficient force to ensure good contact. This clearly shows that none of his conductors were good enough for practical use. Further down the discoverer resumes the filament of his narrative. He says he has carbonised and used cotton and linen thread, wood splints, paper, and lampblack, graphite and tar. Now, not one of these materials without further treatment would make a practical lamp even with a good vacuum.

Turning to the claims. The first evidently refers to his particular way of making filaments and of securing them. The expression "filament of carbon of high resistance," would show that a filament need not have high resistance. This, with the rest of the specification, would lead one to suppose that by filament Edison meant something fibrous. He never calls his tar conductors filaments, or his fibrous conductors wires. No doubt, by carbon wire, he meant the tar compound, and by filament the fibrous conductor. The second claim depends, of course, on the meaning of the term filament. If filament means a long thin thing, his claim is for a conductor made thinner than usual, and nothing more. If filament means fibrous material, the defendants do not infringe it. At first sight it seems odd that Edison would describe carbon wire and not cover it, but it is probable that Edison did not think it of any use. This point will be discussed further on. His third claim does not claim anything now useful, and it is probably bad as being an obvious application of a known method, and might therefore of itself invalidate the patent. Claim 4 calls for no remark. Edison's invention simply amounts to this: it was known that carbon had a high specific resistance, and that a long thin piece had high resistance; but those who tried carbon found it did not last because, though the reason was little understood then, they did not make good vacuums. Swan had already made carbon incandescent lamps of low resistance, and as soon as heating on the pumps became known, lamps of high resistance came into use. Edison's lamps were not, however, practical even then. Paper is the best of the materials described by him, but it is no use until it is "flashed," and even then it is bad. Silk thread treated by Sidot's process and silk or cotton treated by Sawyer and Man's modification were probably the best materials known at the time; and they would have been very much better than Edison's. Maxim was soon in the field with Sidot's process. He passed gas through the crucible during carbonisation. Maxim was also the first to use the modern method of flashing. There is therefore nothing useful or new in Edison's patent. All about high resistance was well known; how to seal into a glass lamp was well known except to Edison; and how to make a reasonably good high resistance conductor was known except to Edison. Edison's patent is also apparently void on the ground of bad faith, though the defendants do not seem to have made much of that. The best, or the least bad, of Edison's materials was paper. Edison knew this, not only before the date of his complete specification, but before he filed his provisional. He had found paper the best on the 22nd of October, and his patent is dated November 10th. Edison patented paper separately afterwards, but that makes no difference. The principle of a patent is that a man is granted a monopoly of a manufacture for so many years in return for introducing a new industry; and he must put the public in possession of what he thinks the best method at the time of the patent, not a few months or a few years after. Edison did not do this. He describes paper quite as a secondary material.

Leaving Sir R. Webster's opening and passing to Sir F. Bramwell, we come to the first extraordinary statement, when that witness states that he never saw a lamp of the same sort as the Newcastle lamp in commercial use or burning at all. Has Sir F. Bramwell never seen a Bernstein lamp? The plaintiffs' witnesses seem to be quite unaware that a low resistance lamp is, as far as the lamp itself is concerned, better than one of high resistance, and that the object of using high resistance lamps is simply to enable the lamps to be run in parallel instead of series. Later on Sir F. Bramwell says the characteristic of Edison's invention is "that it made that which was before an impossibility into a commercial success." Now, lamps made with any of the materials specifically described in Edison's specification have never come into commercial use at all. The first Edison lamps that came into commercial use were, I think, bamboo lamps in 1881, or two years later, when Edison knew how to make more perfect vacuums. No lamps at all have ever come into use with the absurd spiral arrangement which Edison appears to think essential. The same witness says, later, speaking of Lane-Fox's patent, that he knows of "no means in his day of making carbon wire." Does Sir Frederick Bramwell mean to say that prior to Edison nobody knew that a bit of cotton thread could be carbonised, or that arc light carbons could be squirted as thin as desired? He says that in 1878 "no human being, except Edison, knew how to make a carbon filament." If Sir Frederick Bramwell had been well up in lamps, he would have known that strips of such materials as paper occurred to almost everybody who was working at the problem at that time. The whole difficulty then was, not to make a short, thick bit of carbon or a long, thin bit of carbon, but to make a lamp which had a good enough vacuum for the carbon to last in. If lamps were wanted of high resistance, everyone knew at that date that carbon could be made in long thin pieces; even Sir Frederick Bramwell himself had seen charred thread before then: but the difficulty lay in getting a good enough vacuum. A

long thin carbon demanded a better vacuum than a short thick one, and unless Edison could show how to obtain a better vacuum than made at that date he could not show how to make a high resistance lamp. If anyone invented a high resistance or filament lamp it was, I think, Swan, who, with Stearn, was the first apparently to make such a thing. Edison did not know how to make a high resistance lamp in 1879; he merely knew that if a lamp was wanted with a high resistance its carbon should be long and thin, and should be in a good enough vacuum to be durable. He knew that one step towards a good vacuum was a glass globe. Everybody else appears to have known the same thing, but that does not generally deter Edison from claiming an "invention." He also knew that to make a durable lamp with a thin carbon the lamp should be well exhausted. How to do this he did not know any more than others did. He therefore took out a "fishing" patent for a thing that everybody knew was desirable, but no one, not even Edison, knew how to make.

Dr. Hopkinson said that before Edison, incandescent lighting was impracticable, and immediately after it became an important industry. No doubt it was impracticable before, but so it was after until it was known how to make a good high resistance carbon and how to make a good vacuum. The industry did not develop immediately after Edison's invention, and the development was not due to Edison's invention. Arc lamps have come into use since the days of Noah, but Noah did not invent them. Dr. Hopkinson says he thinks no one knew a filament could be shaped before carbonising in Edison's time. The same remarks apply here. To Sawyer and Man and to Swan the obvious and natural thing was to carbonise paper. Moreover, little arc light carbons about $\frac{1}{100}$th of an inch thick are made and are now used in some incandescent lamps; these can be bent about before carbonising. It is to be noted that Dr. Hopkinson and especially Dr. Fleming, who have had more to do with lamps than Sir Frederick Bramwell are obliged to admit more on cross-examination. Great stress was laid on the question of what was called indifferently "elasticity," "resilience," and "flexibility." A great feature in Edison's lamps was made out to be that he showed how to make carbon that would waggle about. In making an incandescent lamp carbon for a high resistance lamp several incompatible qualities are desirable. The carbon should have high resistance and the usual surface. It should be strong. It should be short and thick so as not to waggle about or touch the glass. It should therefore be of high specific resistance so that it can be made short, thick, and strong, and the material should be hard and durable. It is found that a carbon of high specific resistance is always weak and soft and does not last well, so the high specific resistance has to be given up in favour of a harder material. This necessitates a long thin carbon to get the resistance. The disadvantages of the long thin carbon are that it waggles about and is weak. In fact the very qualities which were brought forward as advantages in Edison's lamp are very serious evils. It is the weakness and tendency to waggle about that form the practical limit of the electromotive force that can be made available. It is chiefly for these mechanical reasons that a low resistance lamp is better than one of high resistance. Swan's was therefore a very much better lamp than Edison's in 1879, being more durable, stronger, and better able to work with the inferior vacuum then in use. Moreover, the fibrous materials chosen by Edison are all bad, as they make weak soft carbon. The expansion due to heating need not injure a straight carbon, as a little spring is then given to the leading-in wires by giving them a bend or fixing them at right angles to the carbon. I believe Swan generally used the latter plan. Arched conductors for incandescent lamps were well known at the date of Edison's specification. Dr. Hopkinson says that this ability of Edison's carbon to waggle about allowed it to be moved about easily. This is, of course, absurd. No doubt none of the witnesses have seen lamp filaments made as described in Edison's specification. Carbonised thread is about as limp and as weak a substance as you could well have, and paper is nearly as bad. Plain carbonised paper or cotton have no metallic ring, and have not the beautiful properties claimed for a filament. Edison in 1879 did not know how to make a reasonably good filament.

Dr. Fleming said that an ordinary skilled workman could make an Edison lamp. Of course this really means nothing, because Edison did not describe a commercially useful lamp. No doubt if Dr. Fleming had been asked whether an ordinary skilled workman could make a commercially useful lamp from Edison's specification, he would have explained that the materials described by Edison could not be used in a commercial lamp, and that there were no instructions to enable him to make a reasonably good vacuum.

Dr. Fleming said he could call to mind no incandescent lamps that were used practically which contained a rigid carbon pencil or rod. Yet a few evenings before he had attended a lecture where such lamps were shown by Bernstein. He must surely also have seen Gerard's lamps, which have very fine straight carbons; two straight pieces meeting at an angle at the top of the lamp, and being fixed at the other ends to the leading in wires. These lamps seem to supply the missing link between the filament and the rod or pencil. Later, Dr. Fleming makes out that Sidot's carbon, being a good conductor of electricity, was therefore bad for an incandescent lamp. This would be so if carbon that is a bad conductor were not always soft and weak; the strength is of such great importance that such carbon as Sidot describes would be the best for the purpose. It is always the object of a lamp-maker to get a carbon of as low specific resistance as possible, because it is more durable even when made thin enough to bring up the resistance.

Mr. Imray's opinions have, of course, weight in one direction, as his knowledge of patent law is very deep; but as his evidence was directed to technical lamp work, he was speaking on a subject on which he was no authority. He asserts that all glow lamps now in use are practically of this kind. Does Mr. Imray mean that they have fibrous conductors, or lampblack-putty conductors, or coiled conductors, or high resistance conductors? Whichever he means he is wrong. He again says that Swan's lamp was unfitted for incandescence, and that it did not lead to the practical manufacture of incandescent lamps. Those that know the history of lamps will certainly say that Swan and Stearn and Lane-Fox were the first to make practical high resistance lamps, and that Edison was a long way behind. Edison's lamp did not come into the market at all till he made bamboo carbons. Even now Edison is behind in this matter.

Prof. Dewar's evidence will probably astonish everybody acquainted with the subject. He seems to have carefully not succeeded in making proper carbonised thread according to Sidot's paper. If a carbon is flashed at a low temperature in a rich gas it is rough, uneven, and useless; but everybody knows that a high temperature and small supply of carbon in the gas is needed. Prof. Dewar seems to say that a charcoal conductor would not do because it is a bad conductor of electricity. It is difficult to tell at all from the report what he meant. Cross-examined by Mr. Charles, he says charcoal is not a good conductor of heat "for practical use for the purpose of an incandescent light." What has conductivity for heat to do with the question? Surely the learned Professor was talking great nonsense. If not his evidence should have been valuable to the defendants, for he contradicts Edison's statement that any fibrous vegetable material will do for incandescent lamps. Prof. Dewar also thinks a filament is a fine thread; therefore an ordinary lamp has not what he would call a filament. He goes on to say that a thread carbonised in a hydro-carbon atmosphere, according to Sidot's process, is not electrically continuous, and consists of *petites boules*. One cannot understand what these sorts of statement mean, coming from such a man as Prof. Dewar, and can only say, as they do in the East, "What is all this but bosh? Nothing." The defence seems very feeble, though the

counsel made the best of the slender material supplied them. The main points, that a high resistance lamp is as a lamp inferior to a low one; that Edison did not make a more perfect lamp than those already known; and that he merely claimed a thing that was well-known to be desirable at that date, but was not practicable till much later, were not insisted upon. The judge was allowed to think that Edison's was the first practical lamp. He says in his judgment that it is quite clear that before Edison no efficient incandescent lamp was known, and that Edison's was the first. The judge points out that there is no evidence that Edison knew of the process of 5,127 when he filed 4,576. Now even if he did not know paper was very much better than thread or carbon putty till December, mentioning the fact in his complete of 4,576 would not have been putting a separate discovery into it. All he had to do was to say paper was the best material of those he described, and not that any fibrous vegetable material would do, or that he used a mixture of tar, lampblack, and zinc oxide. But Edison did know of this before he filed his provisional. His lordship was also led to suppose that flexibility was a good point and "rigidity tabooed," and that Edison's filaments were very flexible, and strong and durable.

The Swan and Gimingham patents are not discussed because neither is the least likely to be of importance. Lamps can be made quite well without using Swan's patent if it does hold. Gimingham's patent is not used by the Edison-Swan people themselves. They have given up using sockets, and do not cement by Swan's patent, 4,202, 1881, and are using my patent, 1,178, 1884, instead.

The Cheesbrough case is important, but until people can make lamps again the flashing question does not come up. Lamps can be made without flashing, but it is, no doubt, a convenient process.

The first effect of a lamp monopoly will be that prices of lamps will remain high or go higher, and there will be no stimulus to improvement in their quality because there will be no competition. People often grumble at the present price of lamps. Prices have been high because it takes a long time to get a factory into working order, as the making of lamps is new to all the hands, and an enormous amount of experimenting, and that on a commercial scale, is needed before lamps can be made cheap and well. A factory takes about two years to get into swing, but after that lamps can be made very cheaply. The actual labour and material in practice come to about fivepence halfpenny per lamp sent out when made on a small scale. These are actual figures. On the scale of manufacture of a large company the lamp should be sold at a shilling or eighteenpence. Incandescent lamp making is troublesome, and there are many mistakes and expensive pitfalls to fall into, but if Edison's was a practical lamp, surely after seven years' practice a company should be able to make lamps of the correct electromotive force and current to order at prices that would put competition out of the question.

ON THE CALIBRATION OF A CARDEW VOLTMETER.

IN the researches for determining the degree of efficiency of a Zipernowski-Déri-Blathy transformer which, as commissioned by Prof. Dr. A. von Waltenhofen, I (Karl Zickler in *Zeitschrift für Electrotechnik*) executed at the Imperial and Royal Electrotechnical Institute at Vienna,* the measurement of difference of potential at the terminals of the primary and secondary coils of this induction apparatus was required, and we employed for the purpose Cardew's voltmeter. This instrument, procured from Paterson and Cooper, of London, gives the difference of potential direct in volts, and its manipulation is the simplest possible. To render it suitable for this purpose it had first to be submitted to a close comparison with another instrument, the accuracy of which is recognised, using currents of the same direction. The explanation of the method of calibration adopted, from which follows a process for measuring any potential differences by the introduction of a resistance to the instrument, forms the subject of the following communication. Before entering upon this explanation I must premise a short description of this instrument which is not very generally known.

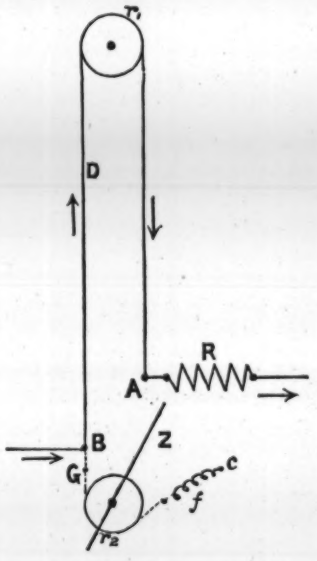

FIG. 1.

The chief constituent of this simple apparatus is, as shown in fig. 1, a platinised silver wire, D, 0·064 millimetres in diameter, which is stretched over the pulley, r_1, fixed at A, and connected at G with a thread which passes round the pulley, r_2, and ends in the spring, f, secured at c. A current passing through this wire heats and prolongs it, thus effecting by means of the tension of the spring a movement of the pulley, r_2, and of the index, Z, with which it is connected. The quantity of heat developed in the wire in a unit of time and the expansion of the wire are proportional to the quotient $\frac{\delta^2}{w}$, if δ represents the difference of potential at the ends of the scale and w the resistance. Thus by means of the position of the index on a scale determined by previous experiments, and extending from 20 to 125 volts, the difference of potential, δ, can be read off at once in volts, it being indifferent whether the currents passing through the instrument are continuous or alternating. The current is conducted to the wire, D, by a thin wire soldered on at B. A resistance, R, which may likewise be conceived in the form of a thin, extended platinised silver wire, serves to increase, if needful, the resistance of the instrument. Both wires, D and R, are enclosed by a tube 91 centimetres in length, consisting partly of brass and partly of iron, which supports the axle of the pulley, r_1, and which, by its expansion, compensates the expansion of the wire due to the change in the temperature of the air in such a manner that the indications of the instrument remain unaffected. A fusible wire of corresponding dimensions protects the instrument from injury by too strong a current. It must be remembered that in this instrument, in comparison with others, we have to do with one whose resistance varies with the magnitude of the E.M.F. to be measured.

Cardew's voltmeter was compared with an accurate Siemens and Halske torsion galvanometer in such a manner, as shown in fig. 2, that both instruments were

* See REVIEW of July 23rd.

applied singly in succession or simultaneously to the resistance, W, which was, along with W′ in the outer circuit of a machine of equal potentials. By varying the resistances, W and W′, the most varied differences of potential could be produced at the points, A and B, and could be measured by both instruments either singly or simultaneously. The indications of the voltmeter plotted in a system of co-ordinates as abscissæ and the corresponding values of the torsion galvanometer as ordinates, yield a curve of potentials which enables us to find the correct value for any potential read off on the former instrument.

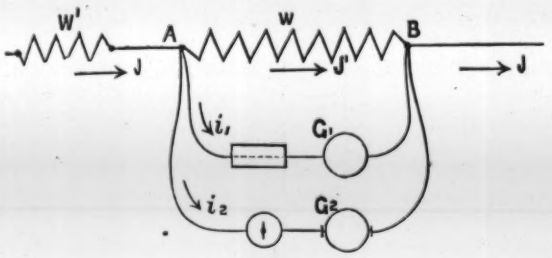

FIG. 2.

For the dependence of the difference of potential, Δ, which appears at the resistance, W, if no instrument is applied to the Δ' existing in it if we suppose in general n measures of potential with the resistances G_1, G_2, G_3. . . . . G n simultaneously applied to it, the formula holds good

$$\Delta = \Delta' \left[1 + \frac{W}{G_1} + \frac{W}{G_2} + \ldots + \frac{W}{G\,n}\right] \quad (1)^*$$

whereby we assume the resistances of the instruments as known. But we know that the resistance of Cardew's voltmeter is of variable magnitude. Therefore in the comparison the arrangement was made that the current, i_2, passing through it could be measured by an accurately calibrated tangent-galvanometer for feeble currents, the resistance of which, 0·25 ohm, in comparison with that of the instrument (over 300 ohms) might be disregarded. We have then

$$G_2 = \frac{\Delta'}{i_2} \quad (2)$$

whence the resistance may be determined.

Two distinct series of experiments were then conducted for the comparison of the two instruments.

1. Both were applied singly in succession to the resistance, W.

For the torsion-galvanometer we obtain from equation 1 for Δ the formula

$$\Delta = \Delta' \left[1 + \frac{W}{G_1}\right]$$

and for Cardew's voltmeter

$$\Delta = \Delta' \left[1 + \frac{W}{G_2}\right] = \Delta' + W\,i_2$$

if Δ' signifies the potentials read off on the instruments. The values for Δ, calculated in both cases, were used for comparing the two instruments, *i.e.*, for constructing the curves.

2. By applying both instruments simultaneously to the resistance. We have then the formula

$$\Delta = \Delta' \left[1 + \frac{W}{G_1} + \frac{W}{G_2}\right] = \Delta' + \frac{W}{G_1}\Delta' + W\,i_2$$

In this case we may use for the construction of the curves either the potentials Δ', as read off directly, or the Δ calculated from them according to the foregoing formula.

The three curves of potential obtained in these different manners were found perfectly identical, whence follows the accuracy of the measurement of the currents.

In the following table are given the values as ascertained by the second process. It appears that the indications of the Cardew voltmeter are at first too small; they then become correct at about 37 volts, and that afterwards they differ more and more from the indications of the torsion-galvanometer. The resistance of this latter instrument together with the additional resistance, amounted to 1,000 ohms.

Nr.	Δ'		Δ		i_2	W
	Tors. Galv.	Cardew.	Tors. Galv.	Cardew.		
1	24·3	23·5	24·6	23·8	0·073	3
2	26·8	25·8	27·3	26·3	0·078	4
3	28·6	28 0	29·2	28·6	0·084	4·5
4	30·5	29·8	31·1	30·4	0·089	5
5	32·4	31·5	33·2	32·2	0·094	5·5
6	35·5	35·3	36·5	36·3	0·102	7
7	41·0	41·7	42·4	43·1	0·118	9
8	46·0	48·0	47·8	49·8	0·135	10
9	49·2	51·3	51·1	53·2	0·143	10
10	52·2	55·1	54·2	57·2	0·153	10
11	56·0	59·5	58·2	61·7	0·165	10
12	60·8	64·4	63·2	66·8	0·177	10
13	65·7	71·0	68·3	73·7	0·194	10
14	70·9	76·6	73·7	79·5	0·210	10
15	77·1	83·4	80·2	86·5	0·230	10
16	85·0	91·5	88·4	94·9	0·251	10
17	89·2	95·6	92·7	99·2	0·264	10
18	94·0	100·3	97·7	104·1	0·276	10
19	98·4	105·3	102·3	109·3	0·293	10

Incidental molecular changes in the measuring wire, especially when the instrument is in frequent use, render an occasional re-calibration desirable.

An examination of this kind, in which the currents passing through the instrument at different potentials are measured, has the advantage of rendering it suitable for the determination of potentials of any magnitude so ever by the introduction of a properly selected and accurately known resistance. This may be effected as follows:

The dependence of the strengths of the current on the potentials read off on the voltmeter may be represented by a curve if we plot out the Δ' as abscissæ and the accompanying i_2, from the foregoing table as ordinates.

The curve of the current thus obtained enables us to ascertain for any potential, as read off on the voltmeter, the current, i_2, passing through the instrument and the additional resistance, Z, whilst the potential curve previously displayed shows the Δ'_1, as corrected from the Δ' read off. The required potential, E, may then be calculated according to the formula

$$E = \Delta'_1 + Z\,i_2. \quad (3)$$

For the resistance, Z, the condition is essential that it is not subject to self-induction, and that it is not appreciably affected by the currents traversing it.

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* From fig. 2 it follows that

$$J : J' = \Delta : \Delta' \quad (\alpha)$$

and the laws of the ramification of currents give

$$J = J' + i_1 + i_2 + \ldots + i_n \quad (\beta)$$

$$J' : (i_1 + i_2 + \ldots + i_n) = \frac{G_1 G_2 G_3 \ldots}{G_2 G_3 \ldots G\,n + G_1 \ldots G\,n} : \frac{G_3 \ldots G\,n + \ldots + G_1 G_2 \ldots G\,n - 1}{G_3 \ldots G\,n + \ldots + G_1 G_2 \ldots G\,n - 1} : W \quad (\gamma)$$

Taking into account the formula β, we find from γ

$$J : J' = G_1 G_2 \ldots G\,n + (G_2 G_3 \ldots G\,n + G_1 G_3 \ldots G\,n + \ldots + G_1 G_2 \ldots G\,n - 1)\ W : G_1 G_2 \ldots G\,n$$

and from this, according to formula α,

$$\Delta = \Delta' \left[1 + \frac{W}{G_1} + \frac{W}{G_2} + \ldots + \frac{W}{G\,n}\right].$$

It may further be mentioned that similar series of experiments for the calibration of the Cardew voltmeter have been executed by the students of the Electrotechnical Institution among their practical exercises, and that the results agreed perfectly with those given above.

ELECTRICAL TRANSMISSION OF POWER IN NEW ZEALAND.

THE *Lake Wakatipu Mail* of May 14th gives the following account of a practical application of electrical transmission of power at the Phœnix Company's gold mine, Skipper's Creek, near Otago, New Zealand :—

The rapid development of the Phœnix mine began to seriously tax the limited supply of the only power available, namely, water, so that, before any further extension of the workings could be undertaken, Mr. F. Evans, the manager, had to solve the (by no means easy) problem of providing a constant and sufficient amount of power for working the various machines used in and about the mine. The power available up till then was supplied by a "Leffell turbine," which was capable under the most favourable circumstance, *i.e.*, when the water supply was plentiful, of working a battery of twenty heads. This amount of power, however, only lasted for about four months ; the water diminishing in volume during the summer and winter months to almost nothing, so that the average for the year was less than sufficient for ten stamp heads. The question was, how to keep the battery and other machinery about the mine constantly at work. Steam-power on a large scale was out of the question, owing to the prohibitory cost of wood and coal for fuel. Water there was none in the immediate vicinity, excepting that already in use. Mr. Evans then turned his attention to the left-hand branch of Skipper's Creek, where there is a large and constant supply of water all the year round. It was no easy matter, however, to see how this water power was to be made available for the mine. A hill over 800 feet in height separates the two branches of the creek, so that to bring the water itself to the mine it would be necessary to construct a water-race three miles in length, costing at least £5,000. The race would have had to have been made above the bush line, so that during the winter months it would have been filled with snow and ice, requiring at least six men constantly employed to keep it in working order and repair. The idea of a water-race had therefore to be abandoned, and some method of transmitting indirectly the power of the water adopted. Transmission by means of wire ropes, compressed air, and electricity were considered, and after thoroughly investigating the three methods mentioned, it was decided that the two former, viz., wire ropes and compressed air, were impracticable under the existing conditions, and that transmission by electricity was the only method that could be economically and profitably employed. When it became publicly known that electricity was to be employed for driving the machinery about the mine, Mr. Bullen (the proprietor) and Mr. Evans were looked upon by many of their friends as misguided enthusiasts, and the usual croakings and predictions of failure indulged in. Now, however, that the scheme is an accomplished fact, they will receive, no doubt, the congratulations they deserve as the pioneers of a system of transmitting power that is likely to play in the immediate future an important part in the development of the gold fields of this colony. Many of our mines are lying idle the greater portion of the year, through want of power to crush the quartz, and for other purposes. Water power there is, in abundance, in most cases within two or three miles, and now that the Phœnix Company have shown that electricity can be successfully applied in utilising distant water powers, we may expect to hear of many other companies following their example.

Having decided upon the use of electricity, Mr. Bullen and Mr. Evans discussed the matter over with Mr. Prince (electrician) with the result that Messrs. R. E. Fletcher & Co., electrical engineers and contractors, Dunedin, were instructed to supply and erect the necessary apparatus for working a battery of twenty stamp heads. The whole experiment being of such a novel, but at the same time important character and realising the fact that the results obtained would be watched closely by not only those directly interested in mining industries in New Zealand, but by many people outside the colony, Messrs. Fletcher and Company determined to leave nothing undone that would secure the complete success of this, the first instance of the electrical transmission of power, on a practical scale, in the southern hemisphere. The choice of suitable dynamo machines for generating the electric power was not a very difficult matter, but the construction of an "electric motor" capable of exerting a force of from 20 to 25 horse-power was quite a different thing. Acting under the advice of some of the best experts in the old country, Messrs. Fletcher and Company decided to use a specially-constructed "Victoria" dynamo machine as the "motor," and two large "Brush" dynamo machines for the "generators."

The machines were supplied by the Australasian Electric Light, Power and Storage Co., of London and Sydney, who own the patent rights. Messrs. Fletcher and Co. being their sole representatives for New Zealand.

It was by no means an easy matter to get the plant up from Queenstown to the mine, a distance of 26 miles, the last 6 miles being through the creek, which has to be crossed and re-crossed no less than 84 times, the Phœnix Company having to do this at their own risk. Mr. Evans successfully managed it, however, but not without the loss of one of his horses ; a portion of one of the generators, weighing nearly a ton, slipping down an embankment—a distance of forty or fifty feet—and dragging several horses with it, one of which had to be killed. Mr. Prince superintended the erection of the electrical apparatus, and had nearly got things ready for a trial, when he met with an accident which nearly cost him his life, being thrown from his horse. Mr. Fletcher had to come up to finish the work, but was not destined to have all smooth sailing, as several faults developed themselves in the motor and generators, caused principally through injuries received in transit. These, although causing some delay, were not of a serious character, and were successfully overcome and repaired.

The house where the electric generators are placed is situated about two miles up the left-hand branch of Skipper's Creek, and is an iron building 60 feet by 20 feet. It is built at the base of a nearly perpendicular cliff, some 200 feet or more in height. An open ground-race half a mile in length brings the water from the creek to the top of the cliff, where an almost perpendicular fall of 180 feet is obtained, the water being conveyed down the face of the cliff by two wrought iron pipes 22 inches in diameter at the top, tapering down to 6 inches at the bottom.

The supply of water from this race is equal to ten heads when at its lowest limit, but much more can be obtained when the creek is in its normal condition. The electric apparatus is only using four or five heads at present, so that there is ample power for future extensions. Two Pelton water wheels drive the generators. These wheels are extremely simple in construction, consisting merely of a cast-iron pulley or fly-wheel six feet in diameter, and six or eight inches in width, having a number of square-shaped buckets fixed around its periphery. A nozzle $2\frac{1}{2}$ inches in diameter throws a powerful jet of water into these buckets, causing the wheel to make about 190 revolutions per minute when working at its full power. Each wheel will exert 50 horse-power if required, but at present they are working at much less. Messrs. A.

and G. Price, of the Thames, the makers, claim an efficiency of from 80 to 86 per cent. The shaft of each wheel carries a driving pulley, which drives by means of a belt an intermediate shaft; these shafts in their turn carry the pulleys that drive the generators. The whole of the machinery is secured to heavy timber foundations.

The electric generators, two in number, are the well-known "Brush" dynamo machines, and are one of the largest sizes manufactured. Used as lighting machines, each would be capable of maintaining forty powerful "arc" lights. They are driven at a speed of from 700 to 800 revolutions per minute, and generate each a current of 10 ampères, having an electromotive force, or pressure of 2,000 volts, which is equal to a little over 26 horse-power, or about 53 for the two machines. The two generators are coupled together, so that each delivers its current into the same circuit—somewhat similar to two small pipes delivering a supply of water into one large one. The current passes from the machines to a "switch" board, which is an arrangement for enabling the machines to be connected together in various ways, connected to or disconnected from the circuit in a few seconds if desired. A little instrument called an "ammeter," or ampèremeter, shows the attendant in charge at a glance what quantity of electricity the machines are generating, so that it is an easy matter to increase or diminish the current by any given amount, the speed of the machines being increased or decreased until the ammeter shows that the proper current is being generated. The water wheels are perfectly under control, and can be turned on or off, either both together or independently of one another. When both generators are working, the wheels are always started or stopped together.

A very peculiar kind of leather belting is used for driving the intermediate shafting and generators, and is the first of the kind, we believe, that has been used in New Zealand. It is known as "link belting," and consists of a number of links or pieces of leather, joined together like the chain in a watch. These belts are very strong, but at the same time extremely flexible, and do not, like many ordinary leather belts, stretch unevenly. A piece taken out to shorten a belt can at any time be joined on again, it being impossible to tell where it was joined in. The current is conveyed from the generating station to the battery house by a No. 8 B.W.G. copper wire (the size of an ordinary fencing wire), and after doing its work there returns by a similar wire to the generating station again. These two wires (nearly three miles in length) are supported on poles in just the same manner as a telegraph or a telephone wire is, and are brought over a hill about 800 feet in height. Lightning arresters, similar to those used for telegraphs, are attached to each end of the wires, to protect the generators and motor in case of a storm occuring and the lightning striking one of the poles or wires. The power lost on the "line" (*i.e.*, the two wires connecting the generators to the motor) only amounts to three horse-power, and could be still further reduced by using wires of larger sectional area, were it desirable to do so.

A telephone also connects the generator station with the battery house, so that the attendants in charge of the generators and the motor can communicate with each other when necessary. The motor, as already mentioned, is a specially constructed Victoria dynamo machine, and when working under its normal condition makes about 350 revolutions per minute. A pulley on the armature shaft transmits the motion by means of a belt to the cam shaft of the battery. By means of a switch, more or less electricity can be sent through the motor, so that the power exerted can be regulated to a nicety. When the motor is stopped for any purpose, and it is not necessary to stop the generators, the current is switched or cut off from the motor and sent through a long series of coils of iron wire. The energy of the current is thereby used up in heating the iron wire instead of working the motor. Although the contract stipulated that only twenty heads were to be driven, at the rate of 70 blows per minute, the apparatus is sufficiently powerful to work thirty if necessary. The average weight of these stamp heads is eight hundred weight. Not the slightest difficulty is experienced in starting or stopping the battery; it starts very easily, and can, if desired, be stopped almost instantaneously. It has not been found necessary to have any experienced hands to work the plant, there being a man told off in each shift to take charge of the motor and battery, no one else, of course, being allowed to meddle with the apparatus in any way.

In conclusion, the success of the whole undertaking (which is unique in its way, as it furnishes a remarkable instance of high pressure electric power) may be fairly said to have been accomplished—in fact, to use the words of the manager, Mr. F. Evans, who has just spoken to us, "the machinery is working beautfully, and the power is sufficient at the present time to keep going at least five and probably ten more stamp heads." The importance of this new application of electric power for the lighting and complete working of an extensive mine like that of the Phœnix, opens up a new era in the economic development of the very valuable and inexhaustible mineral resources of the Wakatipu and other gold fields similarly situated, which are by no means suffering from a want of water power, but rather from the difficult and all-important question which the present undertaking has solved—namely, the means of transmitting that power hither and thither—up hill or down dale—on the mountain top or in the ravine below—as may be desired.

HOW TO WIND AN ARMATURE.

By R. FUGE.

IT is our intention to show here the usual method of winding armatures, which like everything worth learning requires patient practice to make a respectable job of.

We will suppose that the necessary calculations have been made, and that therefore we know how many sections the armature will contain, and how much wire of a known gauge will be wound on each section. Let us take, as an example to describe the method, a Gramme armature. The first thing to be done is to insulate it and to divide it off into the same number of sections as it will contain coils, then, having fixed it down firmly, we may begin.

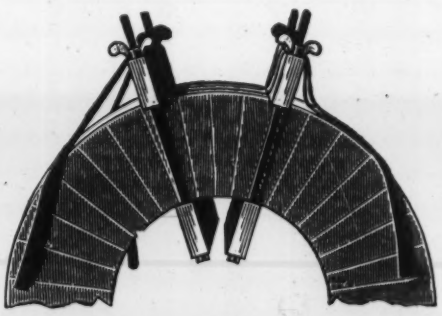

FIG. 1.

Three sections are usually wound at a time, and the first three are kept in position while being wound by guides similar to those shown in their place in fig. 1; two pieces of strong tape are laid along the armature, and, for convenience, are screwed down under the left-hand guide (not lying over it as shown for clearness in the figure) lying over the right-hand one; these pieces of tape should be left sufficiently long for their use,

which will be described afterwards. It will be noticed that the guides have the inside metal blocks considerably longer than the outside; this is to compensate for the smaller diameter inside, which will not allow of the same number of turns in a layer inside and outside, and therefore we have to get a greater number of layers inside than outside. The winder must use his own judgment to tell him when to begin placing turns of a coil which form one exterior layer, so as to form one layer and part of the next on the inside. In modern armatures, by the best makers, of not too high E.M.F., only one, two, or three layers are employed, the E.M.F. being made up for by an increased power of the field-magnets; with these armatures the winder does not have much difficulty to find room for his inside wire. The wire to be wound on each section should now be doubled on itself and wound round the finger into two long coils, A and B, as shown in figs. 2 and 3.

FIG. 2.

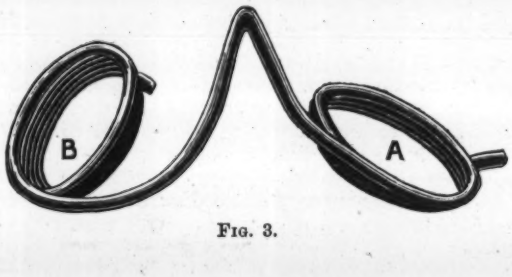

FIG. 3.

First coil, A, is taken and passed over, round and through the core, and the wire pulled tight and straight, a light hammer being used if necessary (fig. 4). Second

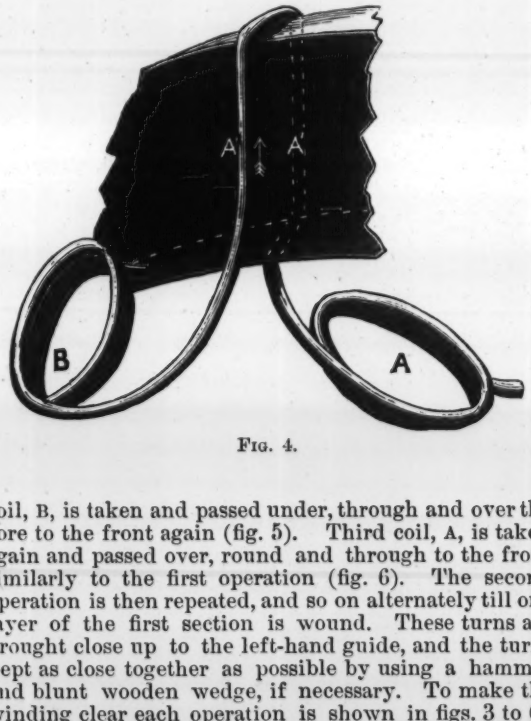

FIG. 4.

coil, B, is taken and passed under, through and over the core to the front again (fig. 5). Third coil, A, is taken again and passed over, round and through to the front similarly to the first operation (fig. 6). The second operation is then repeated, and so on alternately till one layer of the first section is wound. These turns are brought close up to the left-hand guide, and the turns kept as close together as possible by using a hammer and blunt wooden wedge, if necessary. To make the winding clear each operation is shown in figs. 3 to 6; the dotted lines represent the wire behind the core, and the turns A and A^1 have been wound off coil A, and B^1 off coil B, and in the directions shown by the arrows. After a coil has had its turn it is either held tight by an assistant, or a few turns are taken round something so that what has already been wound may not get loose while the next coil is being wound from. When the first layer of the first section is wound, we leave that section and wind the first layer of the second section, and after that the first layer of the third section, and then return to wind the second layer of the first section,

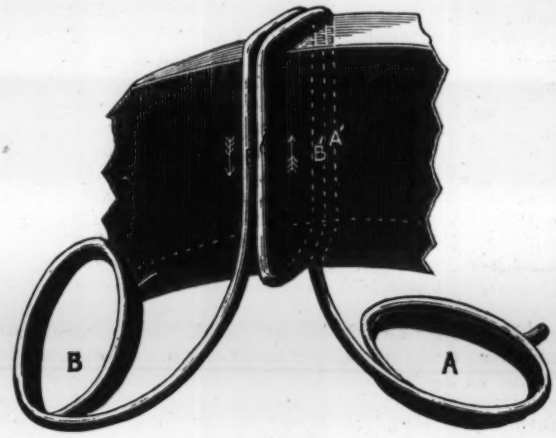

FIG. 5.

and so on till we reach the last layer, when each section has its ends twisted together. The right portions of the two pieces of tape are now taken over the finished left-

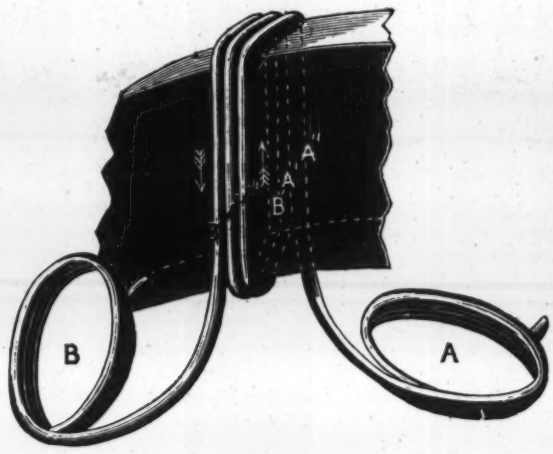

FIG. 6.

hand guide and securely fixed so as to keep the coils in place while the left-hand guide is being removed; it is then placed three sections to the right (see fig. 7) and

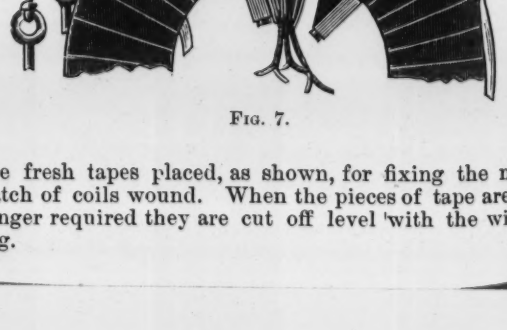

FIG. 7.

the fresh tapes placed, as shown, for fixing the next batch of coils wound. When the pieces of tape are no longer required they are cut off level with the winding.

If the armature to be wound is of the Siemens type, the figures would be the same with the exception that the winding would be carried right round the core (the shaft being in position), and the guides would be pieces of hard wood or metal inserted in saw cuts in the core. Coils A and B, figs. 2, 3, 4, 5 and 6, may be wound on shuttles where there is sufficient room for them to pass. A varnish of shellac and methylated spirits is spread over each layer after it is wound, increasing the insulation and binding the turns together.

It will be seen from the great difficulty of winding many layers on an armature, keeping the top layers true and finding room for the inside ones, what a great mechanical advantage there is in employing *a large armature* with one layer instead of employing a smaller armature with many layers.

THE LABORATORY OF THE GAS ASSOCIATION FOR THE STUDY OF ELECTRICITY.

THE recent progress of the electric light has strongly excited the attention of the partisans of gas, and as the *Bulletin International de l'Electricité* remarked in a recent number, they seem disposed to supply the new system of lighting to private houses. The Gas Company of Vienna has installed, as is well-known, a central station destined to light up two of the principal theatres of that capital. The Paris Gas Company has founded a special office which is to keep it posted up in these novel applications and to inform it on the value of the principal systems in use. Lastly, in one of the largest towns of the south the gas producers, some weeks ago, undertook the construction of works which they have resolved to conduct along with their old establishments.

It is not, however, a mere recent affair for the gas companies to occupy themselves with the electric light. As far back as 1881 they combined, on the proposal of M. Ellissen, to found an electric laboratory in Paris, to which they assigned the task of studying and experimenting on all the systems and apparatus proposed for the production, distribution and use of electricity in its applications to lighting and to the transmission of motive power. This laboratory was at once established, and whilst electricians expected that the Minister of Posts and Telegraphs (Postmaster General) would take an interest in their laboratory, for which the funds were all ready, experiments were undertaken in the most careful manner in the establishment in the Rue Piecini, since transferred to the Rue Appert.

The members of the Technical Society of the Gas Industry, who recently met in congress in Paris, wished to bear witness to the deep interest which they took in their laboratory, and paid it accordingly a formal visit. The visitors, 120 in number, were received by M. A. Ellissen, president of the association, assisted by the learned professor of the central school, M. D. Monnier, director of the laboratory.

The main building comprises, at the centre :—1. The room for dynamos with continuous or alternating currents, with an Otto gas engine of 8 horse-power ; a transmission dynamometer and all the apparatus used industrially for measuring the motor work supplied to the machines and the electric current produced. 2. The room for electric measurements, provided with the most improved appliances. 3. The photometric room in which are placed a Dumas and Reynault photometer and a photometer with a movable screen arranged for the study of luminous intensities at different azimuths. A room is, further, reserved for chemical manipulations and contains a battery of accumulators which supplies the current necessary for the different experiments.

At the visit of the members of the congress the electric lighting consisted of four Cance regulators, one Siemens differential lamp, and one Jablochkoff candle fed by dynamos, which in turn were driven by the gas engine, and several groups of incandescence lamps placed in circuit on the accumulators. Other types of arc lamps (Brush, Sun lamp, &c.) were also shown to the visitors.

Gas lighting was represented by four Cromartie lamps ; the intensity burners of Wenham, Schulke, &c., were also exhibited.

The partisans of gas were thus enabled to take account of the methods employed for measuring the yield of the dynamos, the energy absorbed by the different electric foci, the mean spherical intensity of an incandescence lamp, &c. ; an electrometer and a Siemens wattmeter were arranged for this purpose, the former for the study of alternate currents and the second for continuous currents. Lastly, they had the opportunity of examining the model of an accumulator adopted by the Vienna Company, and a special model intended for lighting up railway carriages.

The question of the cost price of the electric light naturally arose, as also that of its future and of the part reserved for the gas companies. The very successful lighting of the laboratory showed perfectly the advantage which may be derived from the combination of gas and electricity. Lastly—and this is the most important point which it concerns us to remember—the members of the congress withdrew with the conviction that it appears to be the interest of the gas companies to undertake private installations of the electric light, utilising their gas for generating the motive power. This is the solution which our contemporary says it has long ago urged on them, and it now congratulates M. Monnier on the skilful and intelligent direction which he has given to his laboratory, and on the perfect exactness of the results which he has reached.

It quotes, in conclusion, the end of the speech delivered by M. Leclerc, president of the committee, at the banquet of the Technical Society on June 24th last :—"In reality the gas industry, notwithstanding its name, does not limit its action to the production of gas ; it has claimed a wider field by undertaking, or being ready to undertake, all methods of lighting, among others the electric light. *Fiat lux*, such is our motto." This is also the motto of the electricians ; an agreement is about to be arrived at.

SEA BOTTOMS AND SUBMARINE CABLES.

AT the last meeting of the West India and Panama Telegraph Company the chairman, when referring to the breaking of the Trinidad-Demerara section, stated that in several places the iron sheathing wires of the cable had been eaten away, and he attributed the damage to some destructive matter in the mud brought down by the rivers Essequibo and Orinoco.

Were injuries of this nature reported as having occurred where exposed minerals and other matter exist which when coming in contact with the iron sheathing wires set up electro-chemical action, we should not have been surprised, but in the present instance we should have thought that the mud shoals over which the cable in question is laid, and which extend for many miles out from the coast, would have offered an exceedingly safe and advantageous route.

The experience, however, of the West India and Panama Telegraph Company proves that even in such apparently favourable ground there exist very destructive elements, and the corrosion of the sheathing wires in this and similar instances is probably due principally to decaying vegetable substances brought down by floods, and in a less degree to mineral matter carried down in suspension and deposited along the coast.

Throughout the West India islands and the Gulf of Mexico, copper banks, mineral and oil springs, sulphur beds and pitch deposits exist to a very large extent, and combined with the frequent abrupt lava ridges

and sharp coral reefs render the selection of a good cable route a very difficult matter.

In the Atlantic, manganese, a very destructive agent, is found in moderate quantities, very much scattered, and oxides of iron in the shape of outcrops, are of common occurrence.

In shallow water and on rocky ground there is generally a rich growth of submarine vegetation, and experience has shown that quite apart from the mechanical damage caused by the rocks, the free oxygen given off by the plants acts most prejudicially on the iron sheathing wires.

The information at our command is unfortunately not very extensive, but we believe that in the neighbourhood of the Islands of Jamaica, Hayti, San Domingo, Porto Rico, and St. Thomas occur the most numerous outcrops of copper, while pitch deposits, mineral springs, and sulphur beds are principally found round the Island of Cuba. The so-called sulphur beds are patches of black mud highly impregnated with sulphur, and wherever a cable has been laid over one of these patches the iron sheathing has been speedily eaten away. A remarkable example of a submarine pitch deposit occurs in the Bay of Cienfuegos (south coast of Cuba) where the pitch is dredged for, and is employed in pickling telegraph posts, piles for wharves, &c. Between Cuba and Cay West, principally on the Cuban side, large patches of an oily matter smelling strongly of pitch are frequently seen on calm days floating on the surface, and during a repair to one of the cables a mass of crude pitch weighing some 200 pounds was brought to the surface, hanging on to the cable. From time to time round the cays and reefs in the neighbourhood of Cay West a great destruction of marine life takes place especially among those forms which live on or near the bottom, such as sponges, &c. The surface fish do not seem to be much affected on these occasions, and this tends to prove that the source of mischief proceeds from the bottom, and is no doubt caused by some submarine disturbance setting free the noxious matter, whatever this may be.

Reverting again to the outcrops of copper found in certain localities, we know of at least one instance where the sheathing wires of the cable were so rapidly destroyed that a careful investigation of the bottom was undertaken, and it was discovered that the cable had been laid over several patches of copper.

We have only touched upon an infinitesimal proportion of the ground over which cables are laid, and it is difficult to obtain sufficiently accurate and exhaustive details, for cable companies are not, as a rule, very ready to impart particulars of, or call attention to, the mishaps which may occur to their property; but a question of this nature is of so wide and general interest that we certainly think where damage has taken place to cables through the causes we have referred to, full information should be published as to the injury, the locality, and the nature of the bottom.

We have, however, said enough to show the frequent occurrence of matter extremely prejudicial to submarine cables, and we would wish to point out that the question demands, on the part of telegraph engineers, very much more attention than is usually given to it.

Mere sounding, however carefully and extensively carried out, is insufficient, and it is evident that to select the best route for a cable, the nature of the ground should be thoroughly investigated and carefully analysed, so that places where deleterious matter exists can be avoided, or if this is impossible, that especially protected cables may be laid over these dangerous localities. The work of analysing need not entail the employment of much scientific ability, for no very great knowledge of chemistry is necessary.

There is no doubt that even with the greatest precaution many dangerous places will unavoidably remain undiscovered; but this fact should not deter cable companies from carrying out the most careful investigation and analyses of the bottom, for however little may be the information thus obtained, it is evident that the knowledge acquired will be of the greatest assistance in selecting the best route.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 92.)

Saturday, May 15th, 1886—(*continued.*)

Mr. MACRORY: What I meant to say was, they were put into some form before you carbonised them. Was not that so?—They had a form.

Did they retain that after carbonisation?—Some of them had exactly the same form and some had not. You will see the wood is a little twisted; it was not twisted before. But the linen thread I think is in much the same form.

If they were put into anything to retain them in shape, in your opinion would they retain the shape after carbonisation?—Undoubtedly.

Did you make any experiment according to Sidot's second process?—No, I did not; but I saw the result obtained by Prof. Dewar, and that is the kind of result I should expect to obtain from that part of the process. You get short filaments which will not be adapted for making incandescent lamps of high illuminating power, but I know they are very well adapted for making lamps of low illuminating power.

I do not know whether you turned your attention to it, but after carbonisation have the substances carbonised the same amount of flexibility that they had before carbonisation?—I think I said the paper had more flexibility after carbonisation than before, but the others have not so much flexibility. It had much more elasticity, but not so much flexibility.

Cross-examined by Mr. ASTON: Am I not right in saying that you agree with Sir Frederick Bramwell as to his description of what a lamp is, that it may practically be said to consist of a globe exhausted so as to produce as good a vacuum as you can get, with leading wires of platinum introduced into the globe and sealed into the globe, and with a carbon filament conductor placed between and connecting the two leading wires so as to form by that combination an incandescent lamp?—Yes, I think that was his description.

Now let us see what we have. A carbon connector perhaps I might call it so as not to confound it with conductor. A carbon filament connector to platinum leading wires, sealed into a vessel made of glass and exhausted so as to get as good a vacuum as possible?—Yes.

That is the way in which incandescent lamps of all kinds that you know are made?—Yes, up to a certain point.

All these elements are found in all the practically useful lamps that you know of?—Yes.

Prior to November 10th, 1879, did you ever see yourself a lamp having those elements?—No, not before 1879.

In any one of the prior publications which you told my lord you had made yourself acquainted with, do you find any description of any incandescent lamp which had all those elements?—Yes, I think so; in one or more. I think certainly in one. I am talking of a particular figure, if I can find it.

Cannot you remember the name?—No.

You ought to remember the name of the man who has anticipated this great discovery.

Mr. JUSTICE BUTT: You must not put too much upon him. Is it one of those we had this morning?—I am not quite sure. I think it is.

Mr. ASTON: The first was King, the second was Roberts, the third was Edison, 3,986.—Would you be kind enough to repeat your question?

In any one of the prior publications to which you have been referred as being relied upon by the defendants, and with which you have made yourself acquainted, do you find described an incandescent lamp having all the elements which you admit are possessed by Edison, and all practical, useful lamps?—Yes, in the publications of Mr. Swan's lectures I find it.

Before I go to those I will supplement my question by putting it negatively. In no one of the prior specifications of patents do you find an incandescent lamp described having all those elements?—I cannot find one at the present moment, but I have an impression there is one amongst the patents in this book.

Is it one of those to which your attention has been called to-day? Because I will take them *seriatim*. Or is it another one which my learned friend Mr. Macrory has in a wonderful manner omitted? I am sure my friend would draw your attention to the best specification on which he would rely.—If he cannot draw my attention to it I think we may conclude that we have not had it before us to-day.

I take your answer, if I understand it rightly, to be that in no one of the specifications we have had before us to-day is there a description of an incandescent lamp such as we have referred to?—Containing all those points you have mentioned.

Now, we for the moment dismiss the specifications, and we will go to the prior publications of Mr. Swan's lamp. You have not been referred to it by my friend to-day?—No.

Mr. MACRORY: I referred to the lamp.

Mr. JUSTICE BUTT: Not to the published lecture.

Mr. ASTON: Will you turn to the lectures of Mr. Swan, and say

which is the published lecture that you refer to?—At page 69 of my volume of extracts there is a report of Mr. Swan's lecture delivered in the theatre of the Society of Physical Science, Newcastle-upon-Tyne, December 18th, 1879, and in that I find these words: "It will, I believe, be remembered that the lamp referred to consisted of a globe of glass (about three inches in diameter) containing a rod of carbon. The rod was 0·4 inch in diameter and 1·2 inch long."

Will you state what are the elements which you find described there, which you say are found in Edison lamps in ordinary use?—There is first the globe of glass.

I admit that.—There is the rod of carbon.

I will stop there. Do you really mean to say that the rod of carbon is the same thing as a carbon filament?—Now you come to the definition of filament.

No. I come to the definition of a rod.—I certainly should not call that a rod that I saw in Mr. Swan's lamp. If I could—which I suppose is impossible—abstract my ideas from the present case altogether, I do not think even then it would be possible for me to call that a rod.

Mr. JUSTICE BUTT: Will you allow me to say I do not understand why not. I should like to know why you cannot call this a rod.—The term rod always conveys to my mind, whether properly or not, something about half an inch thick. I should call it a pencil, being asked without knowing anything at all about this case.

Mr. ASTON: If that is not a rod that is not the lamp described here. That is what I want you to see. You are saying you find a description; we are not now relying on the lamp. You say a rod of carbon is something different from what is in Mr. Swan's lamp?—Of course I read this description with the light which is afforded me by the specimen of the very lamp which was exhibited on that occasion.

You have no right to put those two together, if you will forgive me for saying so. You are telling my lord to-day that you rely upon this lecture of Swan's of 1879 as showing that there has been a prior description in a published document. When I read that published document, you say that a rod of carbon is not what you find in Swan's lamp. That is what you have said, is it not?—No. I think I said I should not call that a rod.

Therefore a rod of carbon is what you do find in the publication?—Yes.

And you do not find what you call a rod of carbon in Swan's lamp?—I have no doubt that is the lamp referred to here.

Kindly answer my question. Never mind the consequences. You do not find what you call a rod of carbon in Swan's lamp?—I find what other people call a rod, but I do not find what I call a rod.

If this publication does not fit Mr. Swan's rod, which you call a pencil, it does not fit Mr. Edison's lamp, which is a filament?—Now you come to these definitions of rods and filaments.

Answer my question?—I cannot really answer the question without you define.

Mr. JUSTICE BUTT: Show him the lamps. It seems to me that if Swan's is not a rod *a fortiori* Edison's is not a rod.

WITNESS: Certainly.

Mr. ASTON: That is what I thought, and that is what I really thought you would tell me. Now look at this lamp (P 1.) Would you call that which is inside it a carbon rod?—Certainly not.

It is a different thing, is it not?—It is different in the diameter.

This is flexible, is it not?—And a rod may also be flexible.

I ask you whether this is flexible?—That is flexible; there is no doubt about that.

Mr. JUSTICE BUTT: What I want to know is, would it not be much more difficult to call that a rod than a thread?—Certainly.

Mr. ASTON: "A current of electricity," says Mr. Swan, "had been passed through the carbon rod, which raised it to a state of intense incandescence, and even bent it in such a manner as suggested that it had perhaps been softened by the intense heat. After the lapse of about a minute, during which a light was emitted sufficiently brilliant to fully illuminate a room about forty feet square, the intense heat to which the carbon had been raised communicated itself to the platinum sockets, and melted them, and so caused an interruption of the electric current and extinction of the light. When the globe came to be examined, it was found to be coated with a deposit having the appearance of carbon, but as it was difficult to imagine how carbon could have got there, it was desirable that it should be proved whether it was really carbon or not, and my friend, Mr. Barnard Proctor, took in hand to examine into the nature of the deposit. The result of that examination has already been laid before you, as I have mentioned, and you will remember that the deposit proved to be, for the most part, carbon." This was in December, 1879. As far as you know, the lamp he was speaking of was the lamp which he had exhibited, I understand, as far back as February of the same year?—That I really do not know.

You have never heard of any other kind of Mr. Swan's lamp than the one which is before my lord?—Not of that date.

Do you call it a successful lamp?—It is not economically successful, but it is a lamp which is successful in giving brilliant light by a current of electricity.

It is a lamp which gives a brilliant light by a current of electricity being passed through a carbon rod?—Yes; being passed through a carbon conductor, which is here called a rod.

Do not put it longer than you need. Is it not true that a carbon rod having the dimensions here given, the 400th of an inch in diameter and an inch and a fifth in length, would be a carbon rod which expands and contracts to a considerable extent during its incandescence and cooling?—It would no doubt expand and contract, but I should hardly say to a considerable extent.

In the form in which it is there would it not be rigid rather than flexible?—That I cannot say without examining the rod.

If it is held between two platinum wires and is a straight rod, do you not think it would be rigid?—By no means necessarily so. Why should it?

You are a scientific gentleman, and I ask your opinion; would it be rigid rather than flexible?—For anything I know it may be very flexible, but I know nothing about it, because I cannot examine it in regard to that in that glass globe.

Nobody could tell that it was intended to be flexible from the lamp?—Nobody would surmise that it was intended to be flexible.

Mr. JUSTICE BUTT: You are at cross purposes. The witness assumes you are asking whether the material would be flexible; you are asking whether holding it in that position would render it inflexible.

(The Court then rose for the day.)

Monday May 17th, 1886.

Mr. ASTON (continuing his cross-examination of Dr. Frankland): You were asked by my friends on the other side questions with regard to the specifications of King, Roberts, Edison, Lane-Fox, Pulvermacher, Scott, Harrison, and Van Choate, and the publication of Sidot's?—Yes, I was asked as to all those.

And all those were present to your mind, were they, when you gave me the answer on Saturday to the question, "In any one of those prior publications do you find an incandescent lamp having the elements which, you agree with Sir Frederick Bramwell, an incandescent lamp should have in order to be successful?—Yes; I searched through those, and there is not one which fulfils every one of the conditions. I may mention that I have found what I was searching for; it was in Woodward's specification. It comes near to it.

Mr. JUSTICE BUTT: We are not on that; that is not relied upon.

Mr. ASTON: I think as Dr. Frankland is good enough to say he thinks it comes near to it and leaves it there, I am satisfied also to leave it there. (To the witness): Did you ever see a Woodward lamp prior to 1879?—No.

If I understand you rightly, you attach great importance to 3,988 of Lane-Fox? You say it gives all the cardinal elements of an incandescent lamp, and gives them better than anyone has given them up to this date?—I think I said that all those points were cardinal points in an incandescent lamp, not that all the cardinal elements were there.

Although you attach importance to this specification, is it not a fact that at so late a date as April 9th, 1879, Lane-Fox had only got as far as the use of lengths of wire consisting of alloys of platinum and iridium. "In order that the electric force may be conveyed at a high tension," &c., and then he goes on to describe his alloy of platinum and iridium?—Yes.

And then he describes the way in which he proposes to construct his lamp?—Yes. I consider that the clearest description given up to that time as to the manner of constructing an incandescent lamp.

Is it not a fact, whatever your opinion about it may be, that a disclaimer was filed in December, 1882, in which Mr. Lane-Fox gives as his reason for the disclaimer that "whereas since the date of the said letters patent and the filing of the specification thereto it has been discovered that certain parts of the said invention are of doubtful novelty and certain other parts are not of that utility which at the date of the said invention they were thought to be possessed of"?—Yes, that was with reference to the lamp.

But it has reference to that part of the specification which contains the observations and the statements which you say described the part or parts of the lamps?—Oh, yes.

And those are all struck out?—Yes, for want of novelty. The thing had been done before.

Or else utility?—The use of the metallic filament in the place of the carbon filament would be of doubtful utility.

Mr. JUSTICE BUTT: What is relied on here is that Lane-Fox took out a patent for a lamp in which he used, not charcoal as used by Edison, but platinum and iridium. But the point of his patent was the necessity of employing a material of high resistance combined with small surface; that is the main thing. Your opponents say, having that disclosed to you, and inasmuch as carbon conductors were known before, there is no novelty in your substituting a carbon for a metallic conductor.

Mr. ASTON: That is for your lordship.

Mr. JUSTICE BUTT: If that be so, does that affect the matter?

Mr. ASTON: It does in this way. We have on the face of Lane-Fox's disclaimer that, having regard to the enormous advantage of carbon over the metallic conductor, the metallic conductor is of no utility practically. That will be the ground upon which an argument will be founded by and by. (To witness:) You were afterwards referred to a later patent of Lane-Fox's, No. 4,043, of 1878. Is it not true that in the later patent Lane-Fox does attempt to make use of carbon in some form or other?—Yes; he describes a carbon conductor which is made of asbestos saturated or impregnated with some refractory conducting material such as carbon or iridium.

And we may take it that that was the best form of carbon he knew of at that time?—I presume he could not claim at that time a simple carbon conductor, because it had been so frequently used before.

That is not my question. He does not suggest the use of a carbon conductor. There was nothing to prevent him if he had a mind so to do?—I think he does use carbon.

He does not use carbon pure and simple?—No.

And there was nothing to prevent him?

Mr. JUSTICE BUTT: Except that it was not new, Dr. Frankland says. I should like to follow that out. He did not use it because it was not new, and he was justified in using an inferior article.

WITNESS: On the face of it, I should not care to say his conductor was inferior.

Mr. ASTON: But he had a right to use it whether it was new or not, so that it was not the subject of a patent, had he not?—I suppose so.

You know that this description of Lane-Fox's lamp was struck out by disclaimer on June 10th, 1882?—Not the entire lamp.

Among these specifications to which your attention has been drawn, King's is the earliest?—Yes.

In that there is a Torricellian vacuum which you said would be soon spoiled?—Yes.

The next you spoke of, Roberts's, has what you thought might be a thin piece of graphite?—He describes a thin piece of graphite, coke or charcoal.

Is it not true that *r*, *r* in fig. 5, which are the conducting rods, are represented about the same section as the piece of graphite?—It looks about the same, but *r*, *r* are rods which are cylindrical in shape, whilst *j*, the piece of graphite, is flat.

At all events, the conducting wires are not thin?—They are not thin.

Therefore you have not thin conducting wires?—I suppose not.

He did not describe a vessel solely of glass?—No, he does not. There is a metal cap to make it air-tight.

You gave the dimensions of Roberts's conductors as being $\frac{1}{32}$nd of an inch. Did you work out what that would be?—I did not.

You do not deny that the sectional area of the plate of Roberts might be to the sectional area of Edison's filament, as 400 to 1?—I think if you took one of the very finest of Edison's, it is possible.

You remember the $\frac{1}{1000}$th of an inch?—Yes; but he only says they may be rolled out to that thinness.

Mr. JUSTICE BUTT: I suppose you say that not only may it be rolled out to that, but it must be to be of use.

Sir RICHARD WEBSTER: Yes, it must be. It is so used in the lamps.

Mr. ASTON: Another element I want you to consider. Of course the resistance would be different according to the length of the conductor through which the current is passing?—Yes the resistance is directly as the length.

Very well; Roberts's is short?—Roberts's is short.

And Edison's is long?—Yes.

That is an important difference?—Economically, no doubt.

Would not the resistance of Roberts's be only a fractional part of an ohm?—I suppose it would, but I really cannot say without going into calculations.

Will you now turn to Pulvermacher and tell me whether, in your opinion, this enlarged drawing fairly represents the rod spiral application?—Yes, for an arc light.

You have no doubt but that it is an arc light?—That I have no doubt about.

That consists, does it not, of a central carbon core surrounded by a spiral as by an insulator?—Yes.

And then outside that a spiral which is described by Pulvermacher in his specification?—That is so.

The current is sent from the two poles of a battery or a dynamo, one through the coiled spiral and thus to the return wire through the carbon?—That is a very good description, I should say, of what Pulvermacher intends.

The arc is created by the leaping over of the current of electricity from the end of the spiral?—Yes.

Do you find in any part of Pulvermacher any direction to remove the carbon centre and to use the coil alone?—No.

When he comes to his incandescent arrangement, his description is that it consists in inserting in the circuit a vast number of very thin platinum wires at a very little distance from each other, and in such a manner that they represent a bundle of wires nearly similar to a brush composed of platinum loops, the two ends of which are set in permanent contact in a good medium. That is the construction which he uses for his incandescent lamp—he makes no proposition to use carbon?—Yes; to the first part of the question, no.

I suppose if you were to put the rod spiral into a vacuum you would get no result?—I think if you put it in a vacuum you withdraw the central rod.

But if you put it in a vacuum you get no result?—It would require an enormous current.

But you get no practical result in illumination?—No.

Mr. JUSTICE BUTT: It occurs to me to ask if Pulvermacher's rod spiral is so eminently suggestive of Edison's conductor, why did not Pulvermacher apply his to an incandescent lamp?

WITNESS: That is a very difficult question to answer. One wonders now, knowing what we do.

Mr. ASTON: Would there be any radiation of light from the spiral of Pulvermacher, as used by him, in the way referred to by Edison in his specification?—Any radiation of light from the spiral? Oh, no, certainly not. Used as an arc light, no.

You have indications in the specification which would enable you to guess at the area of the rod spiral. The patentee says that they are to be a millimetre apart. Assuming that between each of the circular sections of the spiral rod in fig. 2 there is a millimetre introduced, would this not be between four and five millimetres?—Yes.

Do you not think there is a different character, as regards the sectional area, indicated by the spiral rod in fig. 1, as compared with the wire in fig. 3, or the cord in fig. 2? Is not the area of the spiral rod in fig. 1 manifestly greater than the area of the wire in fig. 3?—Undoubtedly.

Considering that the light in fig. 1 is an arc light, must you not have a suggestion of the amount of area in your spiral in order to have a good arc light?—Yes; but the word suggestion is so indefinite. You must have something larger than what you have in an incandescent light.

And much larger, or there would be waste?—There would be waste.

Scott's never went beyond a provisional specification, did it?—No.

Does the patentee not there say that when he uses an organic fibre, the fibre must not be heated so strongly as to be decomposed? "When the fibres are mineral the heat may be sufficiently high to decompose the flour or starch, but when organic fibres are employed the heat must not be so high as to decompose the said fibres." Is not that what he says?—Yes.

Now, when Edison uses an organic fibre does he not carbonise intentionally so as to decompose the fibre and make it into a carbonised result?—Oh, yes. For use in an incandescent lamp these fibres require to be carbonised.

Mr. JUSTICE BUTT: Does it not come to this, that when Scott is dealing with vegetable fibres he says they are not to be carbonised?—Yes, my lord. This is to be used for an arc light.

I understand that, but still you get a caution against carbonising vegetable fibres?—Yes; he wants a very flexible rod.

Yes; that may be a very good reason?—In the previous part of the specification, beginning at line 17, he says: "When sticks or rods are to be made they may either be made in the same way or may be made by forcing the plastic mass through a hole in a draw-plate; or they may be made in a cylindrical form by rolling."

That has nothing to do with the organic fibre?—Oh, no, my lord.

Mr. ASTON: I pass then from Scott and go to Harrison, who at line 28 says: "My invention relates secondly to the production of flexible carbon, or flexible metalised carbon burners, of any required thickness or length, and this I effect by using threads or filaments, or other flexible material, which I first treat as thread to render it more perfectly combustible, and then coat with carbon or metal, incorporating with them powdered plumbago, &c." That does not allude to the use of flexible carbon burners, however they may be separately, otherwise than twisted into a rope. Now, with regard to each strand of that rope, suppose we take cotton and treat it with nitro-sulphuric acid, we get practically collodium cellulose?—Nitro-cellulose, which may be had of several different qualities. Some will disapper entirely, other qualities will not do so, but will leave a residue of carbon if the air is excluded.

But he intends the carbon to be perfectly incombustible?—Yes; but he uses very indefinite language.

At all events, he does tell you that the acid ought to be a compound acid—a nitro-sulphuric acid?—He says so.

He does recommend it to be an acid that will convert the organic substance into nitro-cellulose?—No, he does not quite say that.

But does he not produce an acid which would have that effect?—He produces an acid which would render it more perfectly combustible.

Would not that be in consequence of its having more or less the character of gun cotton?—More or less. I will explain. It would disappear as gas. But, in the first place, you could not pass an electric current through it. You are asking for an impossibility.

Mr. JUSTICE BUTT: Is this a workable thing?—I should scarcely say it is. I do not understand why he makes these fibres combustible at all.

What I want to get at is this, is there anything in this which to the scientific mind would suggest the employment of such a filament or thread as Mr. Edison used? If not, this is not to the purpose.—I do not think it would.

Mr. ASTON: The next specification was the provisional specification of Van Choate. Is there anything there which would indicate to any person that a carbon filament such as Edison describes is to be used in an incandescent lamp such as Edison describes?—Yes, I think there is.

Perhaps you will kindly tell me what it is?—In the specification we are told that he forms his conductor of asbestos mixed with platinum or carbon, or in combination with them, and so on. And then he says: "the material which becomes incandescent under the influence of electricity, and gives or forms the illumination," &c.; and then he goes on to the metallic substance formed into wire or ribbon, and formed into arcs, spiral, or spiral globe-shaped illuminators or burners.

In what lamps had it been the practice to insert new burners at intervals?—In arc lights.

And instead of that the illuminator of Van Choate is proposed to be used?—Yes.

Mr. JUSTICE BUTT: To be used in the arc light?—No, in the incandescent light.

If I understand it, the material never becomes incandescent at all in the arc light?—Yes, at the ends.

When I read that I confess I thought it meant incandescent.—I have not the slightest doubt he means incandescent.

Mr. ASTON: As a matter of fact he nowhere describes a vessel entirely of glass in which this conductor which he calls his illuminator or burner is introduced, and he nowhere mentions any globe or cover at all for his wire which you say he intends to use in a state of incandescence?—No. I suppose he intended all that to come in his complete specification.

Very well; but between his provisional and complete, as far as we know he did not see his way to put it in? He never did put it in the complete?—No.

And now I ask you in his provisional specification does he anywhere mention or describe any mode of covering up what he calls his burner or illuminator?—I do not think he does. No; he leaves that part untouched.

Now, is it not true that what he describes here, supposing he used two rods of the material he describes, is used like a Jablochkoff candle?—I think not; that would be inconsistent with his instructions.

May it not be a material of carbon?—Yes; but in incandescence as I understand it.

As a matter of fact he could use the material he refers to here, assuming that it is carbon. If you were to have carbon by itself and you were to make it into two wires, might you not use them for an arc light?—Well, you could not if you made them into the globe shaped spiral.

That is only one form—"preferably made." Then we have Mr. Edison's latest description of his lamp, 2,402, of June 17th, 1879, the penultimate specification of Mr. Edison prior to the one in this case. I am now referring to the specification as a whole. You have read it; now is it not true that in that specification Mr. Edison on June 17th, 1879, applied for a patent wherein he proposes to use a metallic conductor?—Yes, that is what he proposes to use.

In that Edison has gone away from carbon for his incandescent lamp and proposes to use a metallic wire?—Yes.

And there is therein contained a complicated arrangement whereby the current when it becomes too intense, so as to operate upon and destroy the metallic conductor, may be short circuited?

The SOLICITOR-GENERAL: I do not want to interrupt my friend, but this patent was only used as to Swan's.

Mr. JUSTICE BUTT: It is not relevant now.

Mr. ASTON: It is in this way. Here you have Edison as recently as the preceding June, insisting on platinum wire being used. (Counsel, however, did not proceed with the point.) With regard to the description of Sidot's in *Comptes Rendus*, I understand you to say that you think Prof. Dewar either did not operate upon the right material or did not proceed in the right way?—Yes; I think I objected in both those respects.

Have you yourself tried what Sidot tells you to do?—Yes, exactly.

"In the tube of porcelain I introduce little bundles of wood, upon which I commence by causing to pass the sulphide of carbon through it with the object of driving out all the air in the tube."—I did not take bundles, certainly; I took separate pieces.

Then he says: "I heat the tube slowly and gradually up to a red heat during about an hour." That you did?—Yes.

"After the cooling, there is found in the tube little sticks of charcoal differing in its physical properties from ordinary charcoal." That is a correct translation, is it not?—Yes. I do not know whether you have any *arriere pensée*. I do not see why this word is not as susceptible of being translated carbon as well as charcoal; but I have no objection to charcoal.

Mr. JUSTICE BUTT: What I have been asking myself throughout is, assuming that M. Sidot has described something very like a filament in a paper under another head and without saying that it may be applied to a lamp, how far that can be considered an anticipation.

The SOLICITOR-GENERAL: It would be a prior publication. What the effect of what is in that paper may be, it is for your lordship to say. These things are brought in merely for the purpose of giving numerous illustrations of the fact that carbon filaments were perfectly well-known things; and Sidot points out that the carbon filament he makes in this particular way is a useful thing for the electric light.

Mr. ASTON: I am coming to that. Now, Sidot has described how ordinary charcoal which is not resonant is converted into a form which is resonant?—I do not think he does say that. He tells you how to carbonise.

"Some charcoals which are distinguished by their elasticity from ordinary charcoals, differing still more from the latter by their great conductibility for heat and electricity, and I estimate, I imagine, I consider, I take it that they may be used to replace the charcoals or the carbons of a Bünsen pile." Now, is not the object of the Bünsen pile to have great conductivity, so that the current may easily pass and that the heat may easily pass?—No doubt great conductivity is a great thing in the Bünsen pile.

Then these are to have the special character of good conductivity for heat and electricity?—Certainly.

Is it not a fact that you want a refractory carbon for incandescent lighting as regards its power of conducting electricity?—No, I do not think so. You want a carbon of poor conductivity; on this account ordinary charcoal will not answer the purpose.

Then you do not want to improve the conductivity of ordinary charcoal?—You want to improve it, certainly.

But do you want to make its power of conductivity high?—You do not want to make it too high.

Mr. JUSTICE BUTT: Would it possess such an amount of conductivity as is required for a Bünsen pile?—It would, my lord. With that degree of conductivity it would be quite useful for an incandescent lamp.

Mr. ASTON: And in that case, would you not have to compensate for its high conductivity by making the section very small and increasing your length?—Yes; that is the way to govern your conductivity by diminishing or increasing the section and length of your incandescent carbon.

So far, all that Sidot has said would apply to an arc light?—It would be suitable for both.

Re-examined by the SOLICITOR-GENERAL: You observed that M. Sidot says: "I have obtained similar results with linen thread, cotton, paper and silk." Now, what do you understand he means by saying that he obtained similar results with linen thread, &c.?—I understand that he means to tell us that when he carbonised those materials you have mentioned in this vapour of disulphide of carbon, instead of obtaining ordinary carbon, he got this peculiar carbon described.

The sonorousness and elasticity of which he has previously described?—Quite so.

I think in your examination-in-chief you produced certain specimens which you obtained by treating these threads in the manner described by Sidot?—I did.

Have you any doubt that you properly described them as carbon filaments?—If by carbon filament we are to understand a carbon thread of very small dimensions, these agree with that description.

Have you any doubt that these carbon filaments which you produce would be suitable materials to be used as conductors in incandescent lamps?—No doubt whatever.

You were cross-examined about Van Choate's patent, and it was pointed out to you that he does not describe the manner in which the receiver is to be exhausted, &c. At the time of day when Van Choate's provisional specification was taken out was it well-known that in order to get an incandescent carbon lamp you must have as complete a vacuum as possible?—It was pretty well known that you must have either a pretty good vacuum or an atmosphere of gas in which the carbon filament will not be destroyed.

Was it in your opinion, having regard to the previous state of knowledge, unnecessary to tell how to use an incandescent burner?—It was unnecessary.

Supposing Van Choate described a burner for an incandescent lamp, would a workman acquainted with the manufacture of incandescent lamps know that he was to put the burner into a receiver either with as complete a vacuum as possible or with an atmosphere of nitrogen gas?

Sir RICHARD WEBSTER objected to this question.

The SOLICITOR-GENERAL: This is only used for the purpose of showing that a carbon filament or thread used as a burner in an incandescent lamp was not a novelty. I do not say that Van Choate described a lamp. He did not describe a lamp. (To witness): Do you, after the suggestions made in cross-examination, adhere to what you said in your evidence-in-chief, that you see described in Pulvermacher's specification a method of making a conductor of carbon so that it can be wound into a spiral form?—Yes.

Do you find there described a particular mixture of which that pencil or filament, or what you like to call it, is to be made?—Yes.

And do you find the mixture described by Pulvermacher identical with one of the materials described by Edison in his specification?—Yes.

You were referred to the drawings to show that the spiral as intended to be used by Pulvermacher was to be of some thickness. You were asked whether from the drawings you would not infer that the spirals were intended to be some millimetres in diameter?—Four or five millimetres.

From your knowledge should you consider that those drawings were intended to be drawn to scale?—No, I do not. Patentees do not make any pretension to such accuracy as that.

Pulvermacher does not confine himself to any particular sectional area or diameter of what he calls a thread?—No.

Now I will ask you to turn to Edison's patent which is sued upon, No, 4576. Applying what Sir Richard Webster says, that the drawings are to show the relative sizes of the different parts, what are you to infer from the drawing of fig. 2?

Sir RICHARD WEBSTER objected.

The SOLICITOR-GENERAL: Does not figure 2 represent a plastic material before it is wound into a spiral?—Yes; it does.

The plastic material is that contained between those two thickened parts, c and c_1?—Yes.

And D and little d are the platinum wires leading in?—Yes.

Well, I ask you whether you see any difference between the sectional area of c, c_1, and that of D, d?—They seem to me to be identical as to size.

(To be continued.)

Electric Lighting in the City.—The Union Bank of Australia has determined to fit the electric light throughout its building in Prince's Street, which is being rebuilt. The order for this has been given to the Electrical Power Storage Company, which it will be remembered has done almost all the bank lighting in the City.

PRIZE COMPETITION FOR THE BEST ELECTRO-MOTOR.

THE editors of *Industries* have handed to us the annexed anticipatory particulars of the first of the rewards which the proprietors of that journal intend to offer for the advancement of practical science. It will be seen that the competition is open to all, and that the list of jurors includes names well known in the scientific world.

"Great and rapid as has been the progress in the application of electricity for lighting purposes, its application as an agent for transmitting and converting power has hitherto not received sufficient attention. Yet this branch of electrical engineering might, if properly developed, become an industry of even greater importance than that of electric lighting, and thus afford profitable employment to a large number of workers and to a considerable amount of capital. We cannot pretend to give a complete answer to the question why transmission of power by electricity has been hitherto so much neglected, but it seems tolerably certain that one of the obstacles which at present stand in the way of a more general and practical development of the subject is the electro-motor itself. In making this assertion, we do not mean to imply that the electro-motors of the present day are imperfect machines if considered from a theoretical point of view. On the contrary, both dynamos and motors are more simple and more efficient transformers of energy than any purely mechanical device yet invented. But, from a practical point of view, they labour under the disadvantage of running at too high a speed, having too great a weight, and costing too much money.

"Before we can hope to see electrical engineering, as applied to power purposes, develop into a great industry, a motor must be invented which will be moderately cheap and light, run at a slow speed, and have the same high efficiency as the heavy quick-running motors now in use. These conditions are jointly difficult to realise, although singly they have been attained by many inventors and manufacturers. There are dynamos now in the market which, when used as motors, give over 90 per cent. commercial efficiency; but these machines are heavy, and run at a very high speed. On the other hand, motors have been constructed which weigh only about 60 lbs. per horse-power; but their speed is either excessive if the efficiency be tolerably good, or their efficiency is very bad if the speed be only moderate. We may mention that 60 lbs. per horse-power is by no means the minimum of weight which has been reached in practice. Thus the motor made by M. Gramme for the Meudon balloon experiments weighs only 38 lbs. per horse-power, but its efficiency does not exceed 57 per cent.

"When comparing different motors as regards their speed, the power developed must also be taken into account, a fixed minimum number of revolutions per minute being evidently far more easily attained with a large than with a small motor of given weight per horse-power. At the same time, where power is required for practical purposes, it is generally convenient to attain it at a speed which is the smaller the larger the power, and *vice versa*, so that, also with a view to practical applicability, the speed and power of electro-motors should vary in some inverse ratio. What the exact ratio should be, must to a certain extent depend on the type of motor, and on the nature of the work for which it is intended; but as it is necessary for the purpose of a competition to fix a certain relation between power and speed, we shall assume that 250 revolutions per minute would be a convenient speed for a motor giving 10 H.P. We have in the above remarks only spoken of motors as usually constructed, *i.e.*, where the power is taken off directly from the spindle of the armature, and where, consequently, the speed of the latter is also that of the spindle from where the power is obtained. It is evident that by the introduction of some kind of speed-reducing gear we could use a small motor of high speed and yet comply with the above condition, provided the gear is sufficiently strong and simple to be of practical use. In this case the motor itself could be made very light, but the weight of the gear and of the slow running shaft from which the power is delivered would have to be added. The power wasted in the gear would also have to be taken into account when estimating the commercial efficiency of the machine.

"There can be no doubt that if a strong, cheap, light, and efficient electro-motor, running at moderate speed, could be invented, the whole industry of electrical engineering would be largely benefited and extended, and in order to stimulate such a development the proprietors of this journal have decided to offer a reward for the best design of a 10 H.P. motor.

"We are well aware that in attempting to judge the merit of a machine from its design only, instead of from tests with machines actually made, great difficulties will be experienced; but if, in order to avoid these difficulties, we were to limit the competition to actual motors, we should prevent many a would-be competitor from devoting his talent and energy to the subject. In that case only those persons could compete who are interested in the question, and have sufficient means to build a 10 H.P. motor, and their number is exceedingly limited. It would practically be a competition between a few of the leading manufacturers. Now, it will be seen by referring to the conditions we have established as a kind of standard of excellency, which every competitor should strive to approach, that none of the ordinary motors at present in the market come anywhere near it. To reduce the thickness of a casting here, to substitute gun metal for cast iron there, or to adopt any other expedient generally resorted to for reducing the weight of machinery, will not improve matters sufficiently. Neither will the substitution of silk for cotton, or square wire for round, or any other plan for the increase of the current capacity of the motor, affect the general result to any large extent. What is wanted is not an old type lightened and improved, but a totally new type. We must have a new invention in the strictest sense of the word in order to approach the conditions laid down as the basis of this competition. The more brains are striving for it, the greater is the probability that such a new invention will be made, and for this reason we believe that our object of stimulating the industry of electrical engineering will be better served by a competition of designs open to everybody, than by one of actual machines practically limited to very few electricians.

"The names of those who have kindly consented to act as jurors will be a sufficient guarantee that the designs will be honestly, carefully, and impartially examined, and that the award will, as far as lies within human discrimination, be given to that design which, taking all things into consideration, approaches nearest to the standard of excellence set up. The secrecy of competitors' names as provided for by clause 4 is an additional guarantee of impartiality.

"Particulars of the Reward.

"1. An award of 100 guineas will be paid to the person who, being the original inventor, sends us the best design of motor complying generally with the conditions stated below.

"2. If the person to whom the award is adjudicated desires it, the proprietors will take out an English patent for him free of cost.

"3. If the person to whom the award is adjudicated desires it, the proprietors will have a model of his motor constructed, free of cost, and present it to the inventor.

"4. The person to whom the reward is adjudicated shall remain absolute proprietor of his invention, patent and model.

"Conditions of Competition.

"1. Any person, not being a member of the staff of this journal, is entitled to compete.

"2. Persons competing must send to the editors, on or before the 31st December, 1886, a complete set of working drawings of their motor. The design must be for a motor of 10 H.P. actual. The drawings must be accompanied by a complete specification, setting forth the principle and details of construction, the weights and quantities to be used in the construction, horse-power, speed, efficiency, current, and electric pressure.

"3. To insure secrecy of names, the drawings and descriptions must not be signed with the name of the competitor, but must bear an assumed name, motto, device, or other distinguishing mark.

"4. A second sealed envelope containing the real name and address of the competitor must accompany each communication, and bear outside the same distinguishing mark. These envelopes will not be opened until the decision of the judges has been published in this journal.

"5. The award will be adjudicated by a jury composed of the following members:—W. H. Preece, F.R.S.; Professor G. Forbes, M.A., F.R.S.E.; Professor W. Grylls Adams, M.A., F.R.S.; and the editors of *Industries*. The jury shall have power to call in other professional assistance, if they deem it necessary.

"6. The designs submitted for competition will be treated as confidential communications, and will only be published with the consent of the respective competitors, the only exception being the design of the successful motor, which will be published as soon as its English patent has been secured.

"7. The person to whom the award is given must enter into an undertaking to work his invention in England for at least one year before working it abroad. By the word 'working' is meant the manufacture of the motor by the inventor himself or by others under his licence.

"The Motors Must Fulfil the Following Conditions.

"1. *General Construction.*—The motor must be a self-contained machine, requiring no special bed plate or foundation. It must be of compact and strong design, occupying little space, and be able to do the work for which it is intended, without danger of breakdown, undue wear, or other inconvenience. It must be able to stand a momentary excess of load, such as is sometimes unavoidable in rough practical work. It must be able to run continuously at full load in a room of ordinary temperature, without undue heating of any kind (whether from mechanical, magnetic, or electrical causes), and no water or other liquid (except a moderate amount of lubricant for the working parts) must be used to keep it cool. The power must be given off from one shaft only, which is to be left long enough to receive a pulley, but the weight of this pulley need not be included in the total weight. This shaft may be that of the armature, or it may receive power from the armature by some kind of gearing. In the latter case more than one armature may be used; but the gearing must form part of the motor, and its weight must be included in the total weight. The efficiency is to be taken as the ratio of the brake horse-power given off from the shaft and the electrical horse-power delivered to the terminals of the motor.

"2. *Electric Pressure.*—The motor must be constructed for an electric pressure of not less than 100 and not more than 500 volts.

"3. *Insulation.*—The design must admit of a perfect insulation of the electrical circuits throughout the motor.

"4. *Weight.*—The total weight of the motor when in working condition must not exceed 950 pounds.

"5. *Speed.*—The speed of the shaft where the power is taken off should not be more than 250 revolutions per minute.

"6. *Efficiency.*—The commercial efficiency should not be less than 80 per cent."

UTILISATION OF WIND POWER IN ELECTRIC LIGHTING.

Now that the storage battery bids fair to become commercially practicable, says a trans-Atlantic exchange, the present time presents a fitting opportunity for some of our readers to exercise their ingenuity, and devise means for utilising the power of the winds to drive dynamos from which to charge storage batteries.

A fair sized modern type of windmill, or engine, as they are now called, will, with the prevailing summer breezes, render available anywhere from 1½ to 3 H.P. Now, given a dynamo, say, of 50 volts E.M.F., and capable of yielding a current of 20 ampères, with an armature speed of not over 240 revolutions a minute, we have all the requirements necessary to charge a plant of 20 storage batteries (160 ampère hours, capacity 0·5 internal resistance), in eight hours' time. That is to say, store sufficient current to operate 10 16-C.P. incandescent lamp (40 volts 1·5 ampères) for something over a ten hours' continuous run—all, and more than all, the amount of light required in any ordinary country dwelling.

We say a slow speed dynamo, for the reason that mechanically they are preferable to high-speed machines, easier to keep in order, and better adapted for the varying power of windmills.

Modern wind engines are regulated to very near a constant speed rotation ; and, when there is any wind to actuate them, there is no fear of their "running away" and destroying the dynamo. Means, however, should be provided to break the circuit between dynamo and batteries, when the speed of the machine, and hence the E.M.F. generated drops below a predetermined amount, otherwise the current from the batteries would make a motor out of the dynamo. It is one great feature of the storage battery that its rate of delivery bears no relation to the rate of charge. Thus the wind engine might vary the speed of the dynamo to such an extent that the charging current would range between wide limits (2 to 20 ampères), and yet the battery be capable (provided the required current had been charged into it) of delivering its usual working quantity. In short, a storage battery has its analogue in the gasometer, with the exception that in the case of the gasometer you can put the gas in as fast as you like, whereas in the storage battery you must not charge at a greater rate than that specified by the makers. Anything less than the maximum current can do no harm.

It would likewise be possible to so arrange the plant as to charge and discharge at the same time, as a charge of a given intensity can be continued long after the cells are full without injury. Various devices, however, have been suggested which act to break the circuit when the batteries are fully charged. On general principles, however, they should be avoided. Fancy devices, which require at least two copper-fastened, four-diploma, electrical engineers to be sent with each instrument to keep them in order, will hardly commend themselves to the prospective users of such a plant. A simple cut-out between battery and dynamo is all that is actually required. We have no doubt that someone will devise a good and cheap plant, such as we have indicated, and which will be largely introduced.

THE PLAN OF THE CONDUIT FOR NEW YORK WIRES.

IN obedience to a resolution passed by the Electrical Subway Commission, on June 30th, the engineer of the board, Mr. John Thompson, has prepared in detail a system of electric subways, to be constructed of concrete. According to the description given by the New York *Electrical Review*, the plan contemplates a main trunk system of conduits connected at intervals with inclusive junction. The main sections are to be rectangular in cross-section, and perforated longitudinally by a series of ducts for the reception of wires and cables. The junction boxes will be shallow cases, formed by a single casting of iron, sunk into the street surface until the edge of the open portion of the box is flush with the paving. They will be provided with heavy outside covers to take the strain of the street traffic, and inside covers screwed down on gaskets to secure water-tight joints. The cables and wires will be spliced, tapped, and handled generally at the junction boxes, the operators being practically at the surface of the street.

To make a continuous subway the conduit sections, after being laid, are to be first brought into alignment by inserting mandrels in the ducts, a cast iron sleeve being then slid over the contiguous ends of the section. To the opening on the upper side of the sleeve a steam hose will be secured and steam turned on. Under the influence of this the ends and sides of the sections will become plastic, the hose will then be removed and melted asphaltum run into the opening, completely filling the space within the sleeve and around the mandrels between the faces of the sections. The joint will thus be welded and form a homogeneous mass throughout, thus, with the added strength of the sleeve, insuring as great atrength at the joints as in any other portion of the sections. The advantage claimed for this process is that the conduit will be made water and gas tight throughout, and that the several ducts will be maintained in perfect continuity from junction box to junction box. The bottom of the trench in which the sections are to be placed will be filled with beton, or asphaltum concrete, to a depth of from four to six inches, thus forming a level and solid bed, and above the conduit a layer about an inch deep of nearly pure asphaltum will be run. Over this will be three or four inches of sand, or just enough to properly bed the paving stones and insure a uniform area of bearing surface. All wires and cables will be easily accessible from the junction boxes, and in consequence of their proximity to the surface, they can be readily inspected, inserted, or withdrawn.

It has been deemed prudent to provide a distinct separation of the systems to accommodate distinct classes of conductors, and the main or trunk conduit will be used for telegraph and telephone wires only. For the arc circuits concrete sections similar to the main conduit will be laid, but with ducts about three-quarters of an inch in diameter. This conduit will also be provided with junction boxes for handling the conductors, and when feasible it will be laid on a lower plane than that of the main subway. The incandescent conductors will also be separately encased.

In extending the main conduit systems by cross connections and branches, and to tracts of the city not thickly wired, it is proposed to simply lay heavy iron pipes of sufficient capacity to meet the requirements of the service. These will radiate from the junction boxes at street intersections in the same manner as the main conduits. The limit to the use of iron pipes in the cross streets, however, will probably be that in which a single cable will afford a sufficient number of conductors for the required service.

Connections with houses, and local or unitary distribution of wires, will be made from the centre of blocks, the wires being brought there from the nearest junction box through a special pipe. In special cases, however, other provision will have to be made, and the plan proposed is as follows : A small iron pipe will be laid on top of the main conduit, thus bringing it in close proximity to the street surface. This pipe will be connected at the junction box in the same manner as the main conduit. At suitable intervals, about one for every two buildings, a small service box is to be provided, having a sealed cap. The cap will come close to the paving stones, and be reached by removing the stones above it. From the boxes will radiate to the right and left smaller service pipes, through which any wire, having been tapped at the junction box, can be led into any house desired and connected with instruments. The pipes used in distributing may be filled

with non-conducting mastic, or separate ducts may be formed in them, as circumstances may require.

The junction box system, it is claimed, offers special controlling advantages, among which are these: The cables may be completely encased through the junction boxes; partitions may be formed in the boxes providing separate compartments for different systems or companies, thereby effecting a complete separation in any inclusive box, and when the service may require it junction boxes may be provided with separate covers, or distinct and separate boxes may be furnished. The iron pipes in the branches and connecting service will be heavily plated with coal-tar pitch to prevent rusting, and this treatment will also effect a degree of insulation in the pipes. In special cases of proximity to steam pipes, the conduits will be protected by a sheathing of mineral wool in the case of the concrete to protect the section itself, and in the case of the iron branches to protect the wires and cables.

Assistant Engineer Kearney, to whom the board referred for report the question of the capacity of the conduit required for different classes of wires in the city, and the order in which different sections of the city can be most conveniently supplied with subways, has made a preliminary report, in which he says that the telephone companies are desirous of having space in the main conduits. Above Canal Street they require 24 ducts of 2½-inch diameter each, and below Canal Street from 36 to 50 ducts, according to locality, of the same diameter.

NOTES.

The Electric Light at a Musical Festival.—On the occasion of an *al fresco* concert by the massed bands of the Portsmouth garrison last week, it was arranged that one of the chief attractions should be the lighting of the ground by electricity. This would have been an extremely simple matter had it been properly carried out, but unfortunately the result was by no means a success—it proved rather a *fiasco*. On the ramparts above the Governor's Green—where the festival was being held—an electric search light was erected by the military authorities, and with the view of diffusing it over the whole space it was turned on a canvas screen at the back of the band stand, which was intended to serve as a "reflector." It is hardly necessary to add that the screen, which flapped about with the wind until it presented an almost tattered appearance, was eminently unsuitable for this purpose, and as a result the powerful ray of light coming from the search light was extremely fantastic and uncertain in its movements, making it necessary for the bandsmen to read their music by the light of ordinary lamps. To make matters worse the wind beat down the smoke from the chimney stacks of the engine house, and the noxious fumes caused the greatest discomfort. The primary cause of failure must have been inexperience on the part of those working the electrical apparatus—members of the Royal Engineers—and it is certainly a great pity that on their account 5,000 persons should have gone away with the idea that there is a fickleness and uncertainty about the electric light which renders its use at present extremely undesirable.

Mutual Insurance of Electric Lighting Stations.—Efforts are being made in America to form an Electric Mutual Insurance Company for the insurance of electric lighting stations and kindred industries.

Central Station Lighting in Vienna.—The *Times* states that the old British Embassy house in the Schenkengasse, Vienna, which is frequently alluded to in Lady Bloomfield's memoirs, is now being converted into a central electrical station, from which the new Hofburg Theatre and other public buildings will be lighted.

The Electric Light and Gas Companies.—Members of the local gas company and several of the manufacturers at Easthampton, Mass., are considering the advisability of putting in an electric light plant for the mills. It will take 1,300 lights for the field under consideration.

Church Lighting.—The electric lighting of the New Herrington Church was carried out by S. F. Walker and Co.

Miner's Lamp.—At the meeting of the South Wales Institute of Engineers on 29th ult. Mr. Sydney F. Walker exhibited a model of the Regent Portable Electric Miner's Safety Lamp. It is calculated to furnish 3 C.P. lamp for about ten hours, and about 1½ to 2 C.P. for 3 hours more, and weighs 3 lbs.

Temporary Electric Lighting.—At Barnack, near Stamford, on July 28th, on the occasion of the opening of a constitutional club and *soirée*, 60 incandescent lamps were used to light a large marquee, and 40 more were distributed among the adjacent trees. Again, on July 29th, an installation of about 250 lamps was used on the occasion of a grand primrose demonstration at Burghley Park, the seat of the Marquis of Exeter. About 90 coloured lamps were used in the gardens, and the remainder gave a beautiful effect to the marquees used for dancing, refreshment, &c. The whole of the lamps in both installations were fed by Gramme dynamos, driven by portable engines.

The Deaf Telephone Ear.—Mr. George B. Shepard, manager of the St. Lawrence Telephone Company, writes from Ogdensburg, New York, to the *Electrical Review*, of New York:—"I notice the Troy papers are claiming as a fact that the use of the telephone has caused deafness in the left ear of a number of their citizens. I am unware how much the Troy subscriber is accustomed to use the phone for dunning customers, but my five years' experience at the business goes to show that that manner of use is the only one in which deafness is caused. In placing instruments for new subscribers I have, in several instances, found them afflicted with impaired hearing in one ear, and unaware of such fact until so discovered. My own hearing in the left ear has become more acute since using the telephone, and several of my operators, whom I have consulted, have had the same experience. I advise new hands, when off duty, to protect their phone ear, as I think the constant use makes it more sensitive."

National Telephone Exchange Association.—Mr. Barney, the secretary of this association, announces that the next annual meeting will be held at the Southern Hotel, St. Louis, Mo., commencing on Tuesday, September 7th.

A New American Cable.—The *New York Herald* says: "It appears to be only a question of a few months' time when there will be direct telegraphic cable communication between the United States, Venezuela and Brazil. About 4,000 miles of ocean cables are to be laid, and the Pedro Segundo American Telegraph and Cable Company is going to do it. The P. S. A. T. and C. Company opened its business offices in New York on July 20th at Nos. 44 and 46, Broadway. The Pedro Segundo American Telegraph and Cable Company is a New York enterprise, incorporated in this State, with $2,500,000 of American capital. The Imperial Government of Brazil and the Republic of Venezuela have granted very favourable concessions to the company. Dom Pedro has given it his name. The new company proposes, so its promoters promise, to establish rates much below those now fixed by the pool ($2.06 a word), and in doing so will be greatly aided by the Government telegraph land lines of Brazil and Venezuela, with which working traffic agreements have already been arranged. The company's cable will be over 4,000 miles long. It is being completed in England, and will be

ready for laying in a few weeks. It can be put down in three months, and will be opened to the public, the officers of the company think, before the end of the year. The southern end of the cable will begin at Viseu, on the coast of Brazil. Thence it will be laid to Cayenne, French Guiana, where it will touch, and then go on to the mouth of the Orinoco River. Here it will connect with some of the land lines in Venezuela. Thence the cable will follow the coast of Venezuela to the northern side, where it will again touch the shore, connecting with Caracas and other important cities and seaports in Venezuela. From Cura, Venezuela, the cable will go direct to Port au Prince, Hayti, an important port, which is now altogether without cable connections. Thence the cable will come in a straight line to New York."

West African Cables.—We are informed that on July 14th, the *Dacia*, belonging to the India Rubber Gutta Percha and Telegraph Works Company, Limited, successfully landed the shore ends at Accra for the Accra-Grand Bassam and Accra-Porto Novo sections of the West African Telegraph Company's system. As already reported, the shore end at Grand Bassam for the Accra-Grand Bassam section was landed on the 12th July.

An Infallible Timekeeper.—Prof. C. H. M'Leod, of M'Gill University, Montreal, P.Q., has, according to the New York *Spirit of the Times*, invented an electrical timing apparatus, which has been tried, and found practicable and accurate. A Montreal newspaper says:—"An electric circuit is made, with connections at the starting and finishing points of a race. In races taking in a lap or more, the start and finish is at the same place, while in parts of a lap there have to be connections for every distance. The time is indicated on a chronograph formed of a cylinder (worked by a clock), which revolves at a uniform rate all through, the seconds being marked in waved lines, giving a distinct mark for each second. The start is made with a pistol, the discharge of which starts the clock, thus timing from the actual moment of sending the men off. In bicycle races the tape, or finishing line, is about half-an-inch off the ground, each bicycle as it goes over the line causing a distinct mark to be made on the paper of the cyclometer, thus taking the exact time of every man in the race. In foot races the wire is breast high, and the pedestrian himself breaks the current and stops the clock. The hundredth part of a second can be caught with this instrument, and, properly handled, as it was by Professor McLeod and his assistant, it is infallible."

Very True.—According to an American paper, one of the most ludicrous errors that ever crept into the press service was recently made in a Pennsylvania town, where a newspaper was informed by telegraph dispatch that "hog rule for Ireland was a failure so far as the elections were concerned."

Electrical Propulsion.—Those who are concerned in developing the application of electricity for the purpose of tram-car propulsion may feel interested in perusing the following statistics, taken from the daily press:—"The cost of horseing the tramway cars in London forms, as may be imagined, a heavy item in the accounts of the several companies. The largest of these is the North Metropolitan, which possesses a stud of 2,681 horses, and during the last six months 57 have died and 111 have been discarded from the service. The loss on the 57 is, deducting £102 received for carcases, £2,054 10s. The horses sold cost £4,199 10s., whilst they fetched but £667 11s. 6d. The total amount of horse depreciation for the half-year is £5,586 8s. 6d. The cost of food for the horses in the six months was upwards of £30,000, of which maize stands for £12,429; oats, £5,887; and hay, £6,622. The expense of shoeing the horses was £2,325. The average cost of a horse per week is 9s.

Incandescent Lamp Patents.—The article which we publish this week from the pen of Mr. James Swinburne will afford considerable gratification to a large number of our readers. A letter also in our Correspondence columns upon the same subject contains several remarks which are very much to the point.

Electricity as Applied to Marksmanship.—In this month's issue of the *Journal of the Franklin Institute*, the lecture by Capt. O. E. Michaelis, entitled "The Applications of Electricity to the Development of Marksmanship," and to which we referred in a previous number of the REVIEW, comes to a conclusion.

The Conservation of Energy.—We have received a reprint of a paper communicated to the Royal Society by Mr. W. H. Preece, on "A New Means of Converting Heat Energy into Electrical Energy." The author is Mr. W. E. Case, of Auburn, New York. We may in a future issue refer fully to this matter.

Colliery Explosion.—Late on Sunday evening an explosion of gas took place at Ladyshore Colliery, Little Lever, near Bolton, by which four men, named Stott, Nuttall, Oliver, and Gilbert were severely burned. The men were at work in the mine with naked lights, when there was a rush of gas and a consequent explosion. Assistance was soon obtained from the bank, and the men were removed to their homes. Stott is badly burned about the face. The colliery is worked throughout with candles, although the Home Secretary is endeavouring to compel the owners to use lamps. Let us hope that he will be successful in his endeavours and that the lamps used may be electric.

Motion for an Injunction.—We believe that the Edison-Swan Company will to-day force forward a motion for injunction against Mr. Holland, of the Albert Palace. This matter was referred to in our last issue, and we understand that the company has obtained *special* leave to proceed as above. Is the suddenness of this action likely to lessen the chances of the Anglo-American Brush Corporation being made third parties? If the Edison-Swan Company proves successful, it probably means that during the whole period of the recess the customers of the Corporation can be harrassed without redress.

Business Transfer.—We understand that Messrs. Judson and Son, Limited, have taken over the business hitherto carried on by Mr. R. Applegarth at the Atlas Works, Ewer Street, Southwark, S.E. Messrs. Judson and Son propose carrying on the business of general electrical engineers. Mr. Applegarth has, we believe, taken offices again in his old quarters at 11, Queen Victoria Street, E.C.

Telegraphic Revenue.—The receipts on the telegraph service from April 1st to July 31st, 1886, amounted to £580,000 against £600,000 received from April 1st to August 1st, 1885.

Throwing Stones at an Electric Car.—At a recent sitting of the Brighton Police Court two lads of ten and twelve were placed in the dock on a charge of throwing stones at Mr. Magnus Volk's electric car and breaking a pane of glass valued at £5. Mr. Volk stated that on the previous Monday evening he was riding on the car towards Kemp Town when several stones were thrown, one of which struck the manager while another broke the glass in question, which was three-eighths of an inch thick. Prisoners pleaded not guilty, but they were each ordered to receive six strokes with the birch rod.

Electrical Transmission of Power in New Zealand.—A pleasant story of colonial enterprise comes to us from the far-off England of the South Seas. Additional power was required for working the machinery in the rapidly developing Phœnix gold mine, situated in the Wakatipu district of New Zealand, and the owners had

sufficient courage to attempt the transmission by means of electricity of the water force from a distant creek. The manner in which the formidable undertaking—for under the peculiar circumstances it was formidable—was carried out is related fully in our other columns. We trust the proprietors of the mine will be rewarded for their boldness in calling in the aid of an unfamiliar power by seeing it continue to perform its duties with economical and practical success.

Underground Wires in New York.—The Underground Wire Commission appointed more than a year ago at New York has at length resolved that the wires must go underground. Amongst the resolutions adopted by the commission are several which hold that currents of great intensity should be separated from all other currents and be placed wherever practicable in a conduit by themselves, and that incandescent lighting wires should be provided for separately and be also placed in a conduit by themselves. The proposal of the Consolidated Telegraph and Electrical Subway Company has been accepted subject to the provision that the company presents an indemnity of $500,000, with sureties to the satisfaction of the commission, and furnishes accurate and satisfactory information as to the patents it holds and its ability to carry out the work. The Consolidated Company has entered into an agreement with the Dorsett Company by which the latter will supply the requisite material and conduits. The plan prepared by the engineer to the Commission is described in our other columns.

These are among the tit-bits which have been occasioned by the decision of the Commissioners:—"All the electric wire companies report an excess of orders." "Anti-induction, non-combustible, double-back-action cables are now at a discount." "Those that gathered the Moss also took in the Flowers, and—we Hes-itate here." (The names of the Commissioners are here trifled with.) "One hundred and forty-nine plans for transmitting electric currents underground can now be bought cheap."

New Knight.—Mr. Philip Magnus, of the City and Guilds of London Technical Institute at South Kensington, is to receive the honour of knighthood. Mr. Magnus was born in October, 1842. He was educated at University College School, and at University College, London, and at the University of Berlin. He graduated in honours at the University of London, in 1863 in Arts, and in 1864 in Science. For some time he held the professorship in mechanics at the Catholic University College, Kensington. In 1880 he was elected organising director and secretary of the City and Guilds of London Institute for the Advancement of Technical Education, and in 1883 he was appointed Principal of the Finsbury Technical College to superintend the working of the new scheme of instruction there introduced, which post he held till the opening of the Central Institution at Kensington. In 1881 he was nominated member of the Royal Commission of Technical Instruction, and has since been asked, in conjunction with Sir Bernhard Samuelson, to represent the Education Department of this country at the International Congress to be held next month at Bordeaux. Mr. Magnus is the author of several papers on educational questions, and of one or two well known scientific text books. He is editor of the "Educational Library," and joint editor of the "London Science Series." Recently he has taken an active part in framing a scheme, which has been adopted by Convocation, for bringing the University of London into closer relationship with its affiliated teaching institutions.

Exhibition in Stockholm.—An exhibition of motors, tools, and machine tools for small industries, and for the production and application of electricity, is now being held at Stockholm, and will remain open until September 12th.

The Upward Battery.—M. E. Hospitalier, who recently visited this country and inspected the Upward battery, writes as follows in the current number of *L'Electricien*:—"The use of primary batteries for domestic electric lighting is desirable in all cases where the importance of the installation does not justify the employment of a steam or gas engine and dynamo machines. A battery suitable for this purpose has been continually sought for with more or less success. The actual tendency, which we have several times supported, is towards giving up direct lighting, in consequence of the want of constancy or low power of the batteries at present known. It is preferable to convey the electrical energy into accumulators, which form at once a reservoir and a regulator, and to charge these accumulators, either continuously or otherwise, at regular or irregular intervals, by the aid of batteries in which the exhausted elements can be easily removed and replaced by fresh ones, without disconnecting the apparatus of production. The battery invented by Mr. René Upward, chief engineer to Messrs. Woodhouse and Rawson, the well-known English electrical manufacturers, does not depart far from this general programme as regards the mode of employment and action, but it opens an entirely new road and constitutes a completely original system in the production of the current, and in the whole of the arrangements for ensuring continuous action." Then follows a description of the battery.

Mr. J. W. King, writing to the *English Mechanic* respecting the Upward battery, with which he has made some experiments, says that if sundry objections which he specifies can be remedied, he considers it without an equal. We believe this is the same gentleman of whom Mr. Sidney F. Walker speaks in his letter.

Bleaching by Electricity.—Mr. Chas. F. Cross, writing in the *Dyer and Calico Printer* for July 15th, denies the statements recently made in the same journal by Mr. Watson respecting M. Hermite's system of bleaching by electricity. So far as I am in a position to judge, says Mr. Cross, after an inspection of the process at the factory of Messrs. Paterson and Cooper, M. Hermite works upon the firm basis of first principles, and it is not a little annoying to find his appeal to technologists for a strict investigation of his process upon its merits prejudiced by irresponsible and baseless condemnations such as those of Mr. Watson.

Fruit as Food.—Mr. J. Salisbury, of 23, Oxford Street, W., sent to the *Echo* of Tuesday last the following plum:—"Fruit is highly charged with an imponderable element, electricity, the active life principle we all possess in a relative degree. Now cook this fruit, and what becomes of this evanescent element? It has dissipated—vanished from the scene, together with much of its delicious odour, and has left us nothing but dead matter. Now it ought to be evident to the merest tyro that, in eating ripe fruit, he is adding to the sum of his own vitality—increasing the fund of his energy without deteriorating his physical powers. On the contrary, by subsisting on dead matter, he subtracts—uses up—his own supply of the vital element to get rid of the inert mass he ignorantly puts into his stomach."

Critical Speed.—Hospitalier, page 234: "The speed at which, on a given circuit, a dynamo begins to give out a sensible current; a very slight decrease of speed practically reduces the current strength to zero, whilst a very slight increase of speed produces a very large increase of current strength. This critical speed has been made the basis of some sytems of regulating dynamos and of governing motors."

The General Post Office.—Mr. C. H. B. Patey, Assistant Secretary of the General Post Office, has been made a C.B.

"Imperial Federation: Home Rule and Imperial Parliament."—This is the title of a work written by "a soldier, an administrator, and an organiser." Perhaps our readers will better understand us when we say that the author is none other than Major S. Flood Page. For the benefit of those who wish to become acquainted with the gallant major's views on matters non-electrical, we may add that the publishers are Messrs. McCorquodale & Co., The Armoury, Southwark, S.E.

A Vast Field.—We read of a new dynamo which dispenses with the ordinary field magnets altogether in favour of the field of the earth's magnetism. The E.M.F. obtained by the armature cutting such lines of force (?) is judiciously withheld. Still it is evident that the machine does not infringe any existing patent which is something to be thankful for in these days.

What's in a Name?—A new dirigible balloon of colossal dimensions is now in course of construction in Berlin. Its capacity is about ten times that of the Renard-Krebs balloon, which has been fully described and illustrated in the REVIEW. The inventor bears the very appropriate cognomen of Gaswindt.

Electro-motors for Railways.—Mr. A. Reckenzaun has written to *Industries*, in reply to the article on this subject in a recent number of that journal to which we called attention in our last issue. He says:—"Your able leaders on 'Electric Railways' and on 'Electro-motors for Railway,' contained in the numbers of *Industries* of 9th July and 23rd July respectively, whilst calculated to impress the reader with the exceptional advantages of electricity as a medium of transmission, contain certain statements which cannot be accepted by any but the wildest enthusiasts. You state, for instance, on page 37, that 'by making every wheel in the train a driver, the acceleration at which the train can start is greatly increased. There could be no difficulty in obtaining a speed of 30 miles an hour within 10 seconds from the moment of starting, and the strain due to inertia would not be greater, nor the sensation to passengers more disagreeable, than is the case now, when trains are stopped quickly by the application of powerful continuous brakes.' I have no experience as regards the sensation produced by starting a train with a force which can get up a speed of 30 miles an hour in 10 seconds, and I doubt whether the sensation would be agreeable, but I cannot see how this rapid rate of acceleration can be attained. You would have to provide machinery of an enormous power to do that, as the following figures will show: in order to give to a ton weight a velocity of 44 feet per second (30 miles an hour) within 10 seconds, we require an initial pull of 308 lbs., neglecting friction. This is nearly 40 times the tractive force required to keep the train in motion on a level railway. It will not be worth while to provide an apparatus which will stand such strains in order to get up a sudden speed, which will undoubtedly be objected to by the passengers, therefore one of the apparent advantages indicated by you can scarcely be supported, and the fact that every wheel can be made a driving wheel is the only point in favour of the system, so far. On page 38 you quote Prof. George Forbes's remarks, made at the Society of Arts, in which that gentleman expressed the hope that he may live to see the day when he could travel from London to Edinburgh in 3½ hours. The distance from London to Edinburgh is about 400 miles; this, in the time given, would thus represent a speed of nearly 10,000 feet per minute, or 113 miles per hour without a stoppage. I take it for granted that you are correct in saying that the wheels and other parts can be made to stand the strains caused by the action of centrifugal force. I also take it for granted that there will be no danger as to the wheels keeping on the rails; but the question which I wish to ask is, what power will be required to propel a train—or say a single carriage—at such a speed; and, further, how can the energy be conveyed to the motors with collecting brushes or contact rollers sliding or rolling along at the rate of over 166 feet per second? In calculating the horse-power, we have first of all to take the tractive force, which at ordinary speeds is 8 lbs. per ton on railways; this, for a 16-ton carriage, inclusive of motor, would give about 40 H.P. effective. But at very high velocities an important factor, that of air resistance, comes in. According to the late Robert Sabine (*vide* 'Electric Locomotion—Limitation of Speed,' ELECTRICAL REVIEW, 16th June, 1883), the horse-power required to overcome the air resistance is only ·18 per square foot of effective surface at 25 miles an hour; at 50 miles an hour this resistance causes an expenditure of 5 H.P. per square foot, and at 100 miles it is as much as 11·8 H.P. per square foot. According to this, a carriage having a flat surface of, say, 36 square feet, pushing the air in front of it at 100 miles an hour, would absorb about 425 H.P. It would, of course, be impossible to put motors under the car capable of exerting such a power. A remedy may be found by providing the front of the first carriage with a conical end similar to a cigar boat, which would penetrate the air; but, in any case, it will be difficult to reduce the effect of air resistance to anything like the equivalent of a square foot of surface; consequently the power which must be given to a carriage which has to make the journey from London to Edinburgh in 3½ hours will be very great, in fact, there will not be room enough for the motors between the axles. Perhaps Prof. Forbes may have an idea as to how to overcome this difficulty. On page 86 you state 'it is quite possible that, as accumulators are improved, they may be used with advantage on long level lines, and if water power be available for working the charging dynamo, the system may, even in point of economy, be found to compete successfully against steam locomotives.' Here, again, I beg to differ, and it is my candid opinion that accumulators, no matter how light, charged with dynamos driven by cheap water power, will never compete with steam on railways, unless it be in a country where coals command a fancy price. Accumulators are eminently suitable for tramcars, where we have to compete with horses; but, as regards railways, their chances are very small indeed. When speaking of motors, you say that there were some in the market which weighed only 60 lbs. per horse-power, but that their efficiency was but 60 per cent. and their speeds excessive. I do not know whether 900 revolutions per minute may be considered excessive, but at that speed, and the weight you give, an efficiency of over 70 per cent. can be obtained, with machines of 4 to 6 H.P. In regard to devices for varying the speed and power of motors, without wasteful resistances, there are several in practical operation. Whilst apologising for the length of this letter, and the manner of criticising a few of the points, I must own that your principal arguments concerning the advantages of electric railways have great weight, and that they concern a subject which is of very high importance."

Temporary Electric Lighting.—On Friday evening, July 30th, a temporary installation of the electric light was made at the private residence of Sir Spencer Wells, Bart., at Hampstead. The current was supplied by means of a Regent primary battery. The table in the dining-room was lighted brilliantly from incandescent lamps enclosed in a prismatic shade suspended from a central chandelier. The great improvement in the purity of the atmosphere of the room when lighted by electricity as compared with gas was remarked upon, and a desire to have a permanent installation as soon as possible was expressed. Sir Spencer had formerly his public rooms lighted with gas, but its effects have proved to be so disastrous to the costly decorations, that after a comparatively short period these have required to be renewed, and he expects that the saving which will be effected from the use of the electric light instead of gas will amply cover the expense of a permanent installation. The temporary installation was carried out by Messrs. Swete and Main.

"Electric Lighting for Private Houses."—A prettily got-up pamphlet with this title, written by Mr. Wilson Hartnell, has reached us. Part I. treats of the "Injurious accompaniments of ordinary modes of lighting," and "Advantages of the electric light." Part II. is more technical, and relates to the arrangement of lights, fittings, wires, &c. Part III. deals with the dynamo, power, &c. At the end is a large sheet of illustrations of various kinds of pendants for the electric light.

Dierman's Primary Battery.—Mr. Dierman writes to say that he will not be able to send us a description of his chlorine battery for another week or two.

The Post Office and the Government.—Mr. Cecil Raikes is to be Postmaster-General under the second Salisbury Administration. This will be his first taste of office, and his conduct in the very busy department which it has fallen to his lot to superintend will be watched with some curiosity. But Governments rise and fall with such rapidity nowadays that it is possible he may not remain long enough at the Post Office to impress his individuality upon the place, and will be under the necessity of retiring just when he has become familiar with the routine and begun to recognise that there are still methods of reform and improvement worth carrying out. If he only succeeds in procuring a greater regard for accuracy in the telegraph department, one great cause of indignant complaint will have been removed. Perhaps the chief offenders in this regard are not so much the clerks at the central and other large offices, but are rather to be found amongst those who combine the occupations of grocers' or stationers' assistants and telegraph operators in small local offices. Some better arrangement than that which exists with regard to this particular class of "civil servants" is, "not to put *too* fine a point upon it," at least desirable.

The Telephone Company and the Government.—The Victorian Government is desirous of entering upon telephonic business, and the *Colonies and India* gives the following account of the position of affairs: "There have been further negotiations between the Telephone Exchange Company and the Victorian Government, and it appears that the company is not inclined to depart from its ultimatum. The position the board takes up is this—that as the negotiations emanated from the Government, and not from the directors, who represent that they have no desire to sell, they are not called upon to modify the terms already submitted to the Government. While no doubt the company is justified in making the best bargain it can for the shareholders, it is pretty certain that the Government, if it cannot buy on its own terms, will grant other concessions that may prove damaging to existing interests."

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Consolidated Telephone Construction and Maintenance Company, Limited.—The annual return of this company made up to the 24th June was filed on the 29th ult. The nominal capital is £243,787 10s. divided into 224,850 shares of 15s. each, and 75,150 shares of £1 each. There has been called up on each issued share (viz., 224,850) the sum of £1, but the shares have since been reduced by special resolution to the nominal value of 15s. The calls paid (as reduced) amount to £168,637 10s.

Telephone Association, Limited. — At an extraordinary general meeting of the members of this association held at 57, Moorgate Street, on the 8th June, it was resolved "that the affairs of the association be voluntarily wound up, and that Mr. Baker Philip Daniels, chartered accountant, of 57, Moorgate Street, be the liquidator thereof." This resolution was confirmed on the 28th June, and has been duly registered.

Gülcher Electric Light and Power Company, Limited.—The annual return of this company made up to the 6th January, was filed on the 21st April. The nominal capital is £150,000 in £5 shares, 20,097 shares are taken up, and of these 5,964 are considered as fully paid, 14,133 are ordinary shares upon which the full amount has been called up. The calls paid amount to £71,589 1s. 8d. and unpaid to £2,143 10s. Upon 1,857 shares forfeited, the sum of £3,067 11s. 8d. has been paid.

CITY NOTES, REPORTS, MEETINGS, &c.

The Globe Telegraph and Trust Company, Limited.

THE thirteenth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Thursday the 29th ult., Mr. John Pender presiding. Mr. William Payton, the secretary, having read the notice convening the meeting,

The Chairman moved the following resolution: "That the report and accounts for the year ended the 18th July, 1886, submitted to this meeting, be and they are hereby received and adopted, and that dividends be now declared, payable on and after this day, as follows, viz., 3s. per share on the preference shares, making, with previous quarterly payments, a total dividend for the year of 6 per cent. on the preference shares, less income tax, and of 2s. 9d per share net on the ordinary shares, making with the previous distributions a total payment for the same period of £3 12s. 6d. per cent. per annum on the ordinary shares." He said:—Before asking you to approve of that resolution, I will make a few remarks on the report, and also give you some information as to the cause of the slightly reduced dividend to-day, and our prospects for the future. Since 1874, when we paid a dividend of 5½ per cent. on the ordinary shares, up to 1885, when we paid 4½ per cent., our dividend has never fallen below 4 per cent., except in the year 1877, when we paid a similar dividend to that which we recommend to-day, viz., £3 12s. 6d. per cent. per annum on the ordinary shares. The cause of this diminution of dividend is the same to-day as it was then in 1877. It has resulted from the reduction of the tariff for messages across the Atlantic. The rate then was 1s. per word, and to-day it is at 6d. for the associated Atlantic companies. Our average dividend for the thirteen years of our existence has been £4 8s. 8d. per cent. Of course, our six per cent. preference dividend has been constantly paid, and if we take the two dividends in combination—that is, the six per cent. and the average of £4 8s. 8d. per cent.—we shall find that we have paid on the combined shares during the past thirteen years a dividend of £5 4s. 4d., or about 5¼ per cent. Unfortunately for us the dividend from the Atlantic traffic has been a descending one. In 1883 the Anglo and Direct Companies paid us £46,300, in 1884 they paid us £44,800, and in 1885 they paid us £38,500. This year we have only received from the Anglo-American Company £14,000, and from the Direct Company £6,000, say together £20,000, which shows a loss of income, as compared with last year, of £18,500, and this is equal to about 1 per cent. on our ordinary shares. We have therefore only to look at the decrease in the revenue which we receive from our Atlantic holding to find that the results of the competition have been to diminish our dividend on our ordinary shares. Gentlemen, that is the dark side of the question at the present moment, the low rates ruling in the Atlantic; but even that dark side has also a bright one. We find that there has been a very large increase in the traffic at these low rates. I might mention that in three months there has been an increase of something like 110 to 118 per cent. We believe that the low rate will develop traffic to such an extent that it may probably twelve months hence enable us to receive, if not the full amount, probably nearly what we have been receiving at the higher rate. I do not mean to say that the sixpenny rate is to be the permanent rate, but this I do say—that the associated companies have resolved to give that rate such a trial as will enable them to judge whether it is to be a paying rate or not. That rests with the telegraphing public. They have now got a rate which cannot be lowered, and if the telegraphing public respond, as we hope they will, I believe that in future the rate for Atlantic telegraphing will be lower than has hitherto prevailed—probably something like the rate which exists to-day. With respect to the other companies, which, as you are aware, form a large part of the capital of the Globe Company, I will first allude to the Eastern and the Eastern Extension Companies. We are also trying in those companies what reduced rates will do as regards increasing the traffic. We have just made a new departure, arising from the Berlin Conference. We have made a new departure from the 1st of July. We have reduced the rates. It takes some time before reduced rates begin to tell, but we hope before long that we may find in the increased traffic some compensation for the reductions

which we have made. Altogether, the Eastern and the Eastern Extension system is as hopeful as at any time since the formation of these companies. The German Union Company is suffering, to a small extent, from the reduced Atlantic rate, and the German-Norwegian Company also. These companies, however, are giving us fair dividends. The Indo-European Company is giving us a very satisfactory dividend. In short, the dividends from the other companies named compensate to some extent for the reduction on the Atlantic companies. That is the great advantage of the Globe Company—that it enables you to get a dividend. Probably had you been in the Anglo-American Company you would be getting no dividend at all at the present time. The future of telegraphy I need not dwell upon, as I have done so so frequently. This, however, I may say—that whether it is in mercantile life or in political life, those who begin to use telegraphy cannot give it up. It has a natural growth. If the country prospers telegraphy must prosper, and therefore, looking at the future, it has all these elements of progress and prosperity in it. I think I have now said all that I have to say at the present time. I would repeat that the Atlantic companies are going to give a fair chance to the low rates now ruling, and that the Eastern and Eastern Extension Companies have laid the foundation of increased traffic by lowering the rates. I hope the result will be that we shall have such an increase of traffic as will enable us, at a very early period, to return to the dividends which we have been paying in the Globe Company heretofore. I now move this resolution, which has been seconded by Sir Daniel Gooch. If any gentleman desires to make any remarks or to ask any question, I shall be very pleased to answer him.

Mr. John Newton said he was sorry that he could not allow the accounts to pass without making his usual objection as regarded the deduction of income-tax. A very important principle was involved in that reduction. He did not know how it might affect him in the future, but it concerned him at present so little as regarded this company that he contented himself with recording his objection. He contended that they had no right to take from him a sum of money as income-tax, and pay the tax to any one else, except to the Government. They did not pay the income-tax at all, and could not deduct it from their shareholders. He would like to ask whether the auditors had seen a voucher for the payment of income-tax to the Government? He knew that they had counsel's opinion on the subject, but he could also produce counsel's opinion to show that they were acting illegally in making a deduction for income-tax. The first declaration in the Articles of Association was as follows:—"That which is at present contemplated as the principal object for which the company is formed is the acquisition and amalgamation in one company of the principal lines of submarine telegraph and the land lines used to connect therewith. It is proposed in the first instance to acquire these shares and other securities of the companies owning them, issuing the shares of this company in exchange for them, or to raise funds for the purpose of paying for them, and, as opportunity offers, acquiring and absorbing the businesses and property of the companies themselves." If they had carried out that principle they would not have had the trouble in the Atlantic at the present moment, nor would the Atlantic telegraph shareholders be now without a dividend, nor would they have seen the competing lines that had been started—lines started for no other purpose than for five or six gentlemen engaged in commerce to oppose them and take splendid positions as directors.

The Chairman: That is a very pretty idea of Mr. Newton's; but would he just show us how we could have prevented the Commercial Company from coming into the field—business men, men of great experience, who, had they looked into the affairs of the existing companies, would have been prevented, I think, from putting such an enormous sum of money as they have put into the bottom of the sea. There were strong representations made to them, but they treated those representations as coming from interested parties trying to dissuade them from going into a very good thing. We had no influence to prevent them. They came in, however, and they are now reaping the harvest in getting probably a lower dividend than we ourselves are getting to-day. As long as you are dealing with men who put aside all ideas of political economy and the question of profit, resolved to spend their money, no combination of men will prevent them from doing so. That has been the case with the Commercial Company. As to the income-tax, Mr. Newton has been consistently in opposition as regards that matter for some considerable time. But I am obliged to say this, that we are bound to respect the law, and bound to go to the very best authorities to read that law for us. That law has been read to us, and it is in accordance with that reading that we are now dealing with this matter. We have taken the very highest authority, and we are obliged to respect the decision.

Mr. Newton: Would you give us your authority?

The Solicitor (Mr. Burt): Sir Richard Webster and Mr. John Rigby. These are two of the authorities that I remember, but I do not know that there were not others. I was not prepared for the question.

The Chairman: There were differences of opinion at the Board with regard to that question, but it has been thoroughly threshed out, and we are acting in accordance with the highest legal opinion in the way in which we have dealt with this matter.

The resolution was carried unanimously.

Mr. John Pender and Sir James Anderson were re-elected directors; the auditors, Mr. J. G. Griffiths, F.C.A., and Mr. William Griffith, B.A., were also re-elected, and a vote of thanks having been accorded the directors, the meeting terminated.

The Anglo-American Telegraph Company, Limited.

THE ordinary general half-yearly meeting of the proprietors of this company was held on Thursday the 29th ult., at the Cannon Street Hotel, Viscount Monck (chairman of the company) presiding.

The Secretary (Mr. T. H. Wells) having read the notice convening the meeting,

The Chairman said: It is now my duty to move the adoption of the report. In doing so I shall not take up your time with any comparison of figures, because from the circumstances of the case anything of that kind would be completely illusory. The rate of tariff has heen changed since the last meeting, or since this time last year, and it would therefore be absurd to compare the figures. I may say, however, in passing, that if you compare the expenditure of the two half years you will find that economy has been studied as far as possible consistent with the maintenance of the efficiency of the service. I have also to state to you, as you will see in the report, that your plant is all in good condition and working order, and that you are carrying a very large, though I am sorry to say at present a not very remunerative, traffic. Well, gentlemen, the truth is, the question we have really to consider to-day, which dominates the whole situation and appears in almost every line of this report, is the mode in which we must meet the competition in which we are engaged. Nevertheless, before I come to that subject, there are one or two topics to which I would wish to draw your attention. You will remember, as you have been reminded by the minutes which have just been read, that at the last meeting we entered into an arrangement for suspending contributing to the renewal fund from revenue as soon as that fund should have reached one million sterling. Speaking roughly, at the time that meeting was held we calculated that that state of things would have arrived at the end of the present year. Now, circumstances have considerably changed since that time. Our revenue has diminished, and we shall not be able, in all probability, to put by to renewal fund within the current half-year—the half-year which is just beginning—as much as we should have done if our income had remained the same. Nothwithstanding this, we shall be able, I hope, to put by a considerable sum to that fund, and if it will not probably attain to the entire amount of one million by the end of this year, it will come very near to it—it will come so near to it that your directors are disposed, as at present advised, not to disappoint the hopes of those who took that view of the matter, and they will suspend, if circumstances continue the same, any addition from revenue to the renewal fund at the end of the year 1886. Gentlemen, of course I need not say that this proposition is dependent on the same conditions which attached to the original agreement, viz., that we should not meet with any extraordinary disasters in the meantime. Well, gentlemen, there is another matter which was alluded to at the last meeting. Some gentleman in the room attached to some words that dropped from me a meaning which I never intended them to bear. He imagined that we were going, in case of a war of rates or of competition, to make use of the renewal fund to tide over that opposition. I at the time stated to you my opinion that any use of this fund beyond that for which it was originally intended, viz., the renewing of your plant, would be a gross case of malversation on the part of the directors. I still adhere to that opinion, and I believe the great body of the shareholders would be disposed to trust the present board in the matter. At the same time contingencies might arise—we might pass from the stage and others take our place; but I am authorised by the board to assure you that no expenditure of this fund shall take place, except for the purpose of repairs, without the shareholders being consulted on the subject. There is yet one other matter. I dare say some of you have noticed the decision in one of the courts of law, that it is not legal for directors to pay the expense of proxies out of shareholders' money. That has been so decided, and having been so decided your directors, of course, are bound by the law, as long as that case remains undisturbed. We have therefore come to the conclusion that all expense of proxies, stamps, printing, posting, and so on, shall be paid for by the directors out of their own individual fees, and that no portion of that expenditure shall any longer be charged to the shareholders. I now come to what is really the great question, and that is the competition in which we are engaged with the Mackay-Bennett cable. We were often denounced as monopolists; but, to be candid with you, that is an accusation that sits very lightly on my conscience. I have always held that my first duty to the stockholders of this company was to obtain for them the best return for their money that could be obtained. If that can be done by securing a monopoly, I see no reason why we should not take that course, and in truth the people who accuse us of being monopolists suggest to us that we should create a natural monopoly by reducing the cost of our work, so as to enormously increase our receipts. Hitherto we had acted on the principle that where combination is possible, competition is not likely to occur. If you cast your eyes back for 20 years, when this company was first established, and when telegraphic communication across the Atlantic was first brought into existence, you will find that the charge for a message across the Atlantic at that time was £20. Well, no one objected to that at that time. We had never been used to telegraphy, and we were overjoyed to be able to send a message across the Atlantic in a minute or two at any price. However, not long after that occurred, people began to think that those who were carrying the messages at £20 a message must be making rather a good thing of it, and a rival company started up. I am sorry to say I had something to do with that company

myself, and we found when we laid our cable that we were not at all mistaken in our speculation, and that it was a very good thing. However, after a very short time, proposals were made to us, and we were amalgamated with the original Anglo-American Company, and for a short time we continued to have a monopoly of the telegraph trade to America. But other people began to think there was something more to be made out of it, and not long after the Direct Cable Company arose. That was treated in the same way, because though we did not amalgamate with it, we had a tariff arrangement, and it came to practically the same thing. That immediately led to the laying of other cables, and I need not pursue this history further, because you are all aware that each one of these arrangements was succeeded by the institution of a new company. A new competition arose, people thought there was something good to be got out of it, and they went in for additional cables. Naturally it has now come to pass that there are cables enough in the Atlantic at the present day to do about ten times the work that they are called upon to transact. When the Mackay-Bennett cable was started we determined to try the effect of fair competition. After a short time we found—and I do not want to complain of the Mackay-Bennett people, because they were perfectly justified if they thought they could get a good thing in getting it any way they could—but we found they were giving exceptional advantages to individuals, and that they were completely undermining our *clientèle*. Therefore we found that we must come to a tariff that would lead to a regular competition and hostile proceeding on both sides. We put down, therefore, our tariff to 6d. a word, as you are aware. Well, the Mackay-Bennett Company continued to charge 1s., and, wonderful to relate, I believe they are getting people to pay 1s. for what they can get for 6d. at this moment. I do not believe that such a thing will last. I believe they adopted a low tariff, supposing that we had merely adopted a temporary measure which would not be persevered in. We have determined to try an extensive and persistent low tariff, with the view of stimulating the increase of traffic, and seeing if we cannot make a good living on a basis that cannot be upset. We have some encouragement, as you will see by the report, in that policy, for within a very short time of the institution of the 6d. a word tariff our traffic more than doubled—the report states that it is 110 per cent. increase. Well, we determined to try whether that increase cannot be made greater, and whether we cannot bring the traffic under a low tariff to such a point as will enable us to make a dividend for you in a way that will not encourage future competition, and will be permanently beneficial to your company. Gentlemen, that is the policy which your directors have at the present moment adopted, and which they are thoroughly determined to persevere in until they see whether it can be worked with advantage to you. I will not conceal from you that it is a policy which will draw largely on your forbearance, and it cannot be carried into effect without your giving an extended support to your directors. Therefore, I hope, in the interests of this company and of the stockholders themselves, that you will join as one man with the directors in instituting and maintaining this policy, and in giving it a fair, extensive, and complete trial. I do not think it is necessary for me to trouble you with any other matter. I have described as succinctly and as clearly as I could what our intention is, and I shall now, therefore, move "That the report of the directors and accompanying statement of accounts to the 30th June, 1886, submitted to this meeting be, and the same are hereby, received and adopted."

The Marquis of Tweeddale seconded the resolution.

Mr. Thomas Smith, of York, said that, as the representative of nearly a million of stock, he supported the adoption of the report. It was encouraging, under the circumstances, to find that the traffic at the reduced rate of 6d. should have more than doubled in the first month after its introduction. The result was not so unsatisfactory also if they thought of the continued depression of trade and the unfair competition they had to contend with. At the last meeting the Chairman had indicated that an agreement for an amicable arrangement of traffic with the Bennett-Mackay Company might be arrived at upon equitable terms. The Bennett-Mackay Company, however, had been most outrageous in their claims of 40 per cent. of the whole traffic and other preposterous terms based on their traffic, obtained by rebates and otherwise. Of course such terms could not be entertained, and the Bennett-Mackay Company declared war upon this company by immediately reducing the rate from 1s. 8d. to 1s. per word. The board of the Anglo-American then wisely reduced their charge to 6d., thus checkmating the game of rebates, which would have been carried on had the rate been made a shilling one. The policy of the board had hitherto been one of conciliation to all comers, but the time had now arrived when company promoters should be taught that there was no room for fresh cable schemes across the Atlantic, and that no further concession would be made. The other company, he believed, had not yet been able to place their stock, and as the public would not have them these millionaires had been obliged to borrow a large sum of money at 6 per cent. in debenture bonds, he believed. The shareholders of the Anglo-American Company must, therefore, exercise a little patience. He had no doubt the present contest must soon end. Their action at present was one of self defence, but if the directors now allowed their opponents to escape without making such an example of them as would deter all promoters for the next 20 years from interfering with their just rights, they were not the friends of the shareholders. He only regretted the board had not adopted this policy much earlier.

Mr. Griffiths said that the last speaker had come forward as the representative of an association called the Anglo-American Shareholders' Association. He (the speaker) happened to be a member of that association, but he differed altogether from the policy advocated by Mr. Smith, and protested against his appearing as the advocate of the association. It had been said that they possessed a renewal fund, which was shortly to cease; but what was the advantage of the renewal fund when they already had more cables than was sufficient to transmit ten times the present amount of business? Why should not this renewal fund, therefore, be utilised for the purpose of equalising dividends? The proprietors had it in their power to do this. They were told that the traffic had increased by 110 per cent., but they were not told at the same time that during that particular period there was a great political crisis in this country, and that the press messages arising from that cause would increase the business enormously. It was said that sooner or later a low tariff would be necessary; but the past showed that the company had wasted its resources and brought no return into the pockets of the shareholders.

Sir John Swinburne asked if the Board intended to add the interest of the reserve to increase that fund after this year?

The Chairman replied affirmatively.

Mr. Eron asked why so large a sum as £50,000 should be set aside to the reserve at one time.

Mr. Jackson repudiated the idea that Mr. Griffiths represented the feelings of the Anglo-American Shareholders' Association, as he had not attended the sittings of that body. He was glad to find that the management of the company was waking up to the duty of studying the convenience of their customers. This company had been a pioneer company, and pioneers too often sowed for others to reap; but they had the future in their hands, and a traffic at a low tariff would employ all the cables. The average dividend for the last ten years had been £3 10s. per cent.

Mr. Newton said that those shareholders who had joined the Globe Submarine Trust had received 5¼ per cent.

Mr. Chester said he was accustomed to strange changes, but the policy the chairman had that day advocated was the strangest change he had ever seen. For years they had been told from the chair that a 2s. rate was not a paying rate, and that any step in the direction of reducing the tariff was entirely out of the question. Now they heard that here were prospects of success with a 6d. tariff. He thought the change a wise one, but it was nevertheless remarkable.

The Chairman: I have often said that we have tried different rates of tariff, and that up to this time we have never found the lowest rate we tried sufficiently remunerative to go on. But we have never before tried for any length of time so low a tariff as at present, and the Board were astonished, I am bound to say, at the extraordinary rise which took place in the traffic of the company immediately on the institution of so low a tariff as sixpence. The gentleman has sneered a great deal at the past policy of the board, but we acted according to the best of our lights. We do not claim any character of infallibility, and if we find we have been wrong we are ready at any time to retrace our steps. There was one observation made by Sir John Swinburne, which, though I have often explained the matter in this room, I should like to explain again. He says I stated that we have the capacity of carriage of traffic across the Atlantic very far beyond the traffic that we have to carry. Therefore, he says, why build up a reserve or renewal fund for the purpose of renewing cables when you have too many? If all the cables in the Atlantic belonged to this company it would be a very good argument, but we own only four out of eight, and the retention of our portion of the income depends on our keeping up these four cables. A question was asked as to adding the interest of the renewal fund to that fund. That action was based on an arrangement come to in this room with the shareholders generally at the last meeting, and it would not be acting rightly if the arrangement was not duly carried out. The placing of the £50,000 to the renewal fund was also part of the arrangement entered into with the shareholders at the last meeting.

The resolution was then put and carried.

A vote of thanks to the Chairman brought the meeting to a close.

Submarine Telegraph Company, Limited.

THE half-yearly ordinary general meeting of this company was held at 2, Throgmorton Avenue, on Tuesday last, Sir Julian Goldsmid, Bart., M.P., presiding.

Mr. S. M. Clare, the Secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, stated that the diminution in the length of the messages to which he had referred on former occasions, had continued, and the result had been that they had received considerably less than in the corresponding period of 1885. At the same time the expenditure had increased. They had carried in the half-year 20,777 more messages, but the number of words had been 747,315 less. In January, 1885, the average length of the messages was 11·80 words, whereas in the same month of 1886 the average number was 11·10; in February, 1885, it was 11·75, and in the same month of 1886, 11·07; March, 11·69 and 10·95; April, 11·86 and 11; May, 11·62 and 11·11; June, 11·57 and 11·08. The total gave an average length of the messages for the six months ended June 30th, 1885, of 11·72 words, whereas the average in the past half-year had been 11·05 words. The most important item of increase in the expenditure had been on the cables. They would remember that in the previous year or two

they had been singularly fortunate in regard to accidents to the cables, and the expenditure on that head had, therefore, been comparatively little. In the past half-year, however, they had been less fortunate, and they had had to put in cable of the value of £1,700 more than in the previous half-year. They had several classes of clerks, and the system adopted for their promotion was a good one, though it had cost them a great deal of money. They had come to an amicable arrangement with the French Government as regarded the payment of the clerks in Paris, but that had involved a payment of some £1,200 more. In these circumstances they were enabled to pay a dividend at the rate of only 12 per cent. per annum. He was glad to say that there were indications of more business for the current half-year than for the six months which had just elapsed, and, consequently, they hoped to be able to submit a more satisfactory report at the next meeting.

The Hon. Ashley Ponsonby seconded the motion, which was carried unanimously.

The Chairman next moved that, in accordance with the recommendation of the directors, a dividend for the half-year to June at the rate of 12 per cent. per annum on the capital of the company, free of income-tax, be paid.

The Right-Hon. Robert Bourke, M.P., seconded, and this motion was also agreed to.

The two retiring directors, the Hon. Ashley Ponsonby and the Hon. H. R. Brand, were re-elected, as also were the auditors, Mr. William R. Cole and Alderman Sir Thomas Dakin.

The usual votes of thanks were accorded, and the meeting terminated.

The National Telephone Company, Limited.

THE report of the directors for the year ending 30th June, states that the capital expenditure for the year, including the purchase of the system of the Dundee and District Telephone Company, Limited, has been £39,930 7s. 7d., against £53,290 17s. 1d. in the previous twelve months. The gross revenue allocated to the past year is £75,635 5s. 8d., against £62,525 18s. 6d. allocated to the previous year, and the amount carried forward to next year is £43,985 18s. 6d., against £38,641 13s. 10d. carried forward last year. The annual rentals on the 30th June reached £80,674 2s. 8d., against £70,943 11s. 3d. at the corresponding date of the previous year, showing an increase of £9,730 11s. 5d. After providing for the accrued interest on the debentures, the dividend of six per cent. on the first preference shares, the dividend of 6 per cent. on the amount of second preference capital called up, and after having paid an interim dividend for the first half of the year at the rate of 3 per cent. per annum on the ordinary capital, there remains a balance of profit amounting to £10,822 15s. 3d. Out of this the directors propose to allot a further sum of £7,875 to the payment of a dividend upon the ordinary capital for the second half of the year, at the rate of 3½ per cent. per annum, and, besides placing £2,000 to the reserve fund, to carry forward £947 15s. 3d. To the reserve fund of £5,000, which was taken last year out of the amount carried forward from the profits of that and previous years, the directors propose to add, as indicated in the last sentence, a further sum of £2,000, which will increase the reserve to £7,000.

The company has continued the erection of trunk wires to connect different towns in various parts of its territory, as well as for the purpose of hereafter substituting those rented from the Postmaster-General in the Glasgow district. The company has now 363 miles of trunk pole lines, carrying 1,216 miles of wire.

The revenue from annual renters is growing steadily, whilst that from fee messages shows a rapid and regular monthly increase.

During the past year the company has opened telephonic exchanges in nine towns which did not previously possess the advantage of a telephonic system, and further development in the same direction is in progress.

The United Telephone Company has again met with decisive success in the defence of its patents against infringers.

The South of England Telephone Company, Limited.

THE report of the directors for the fifteen months ending 30th April, 1886, states that up to the date given a sum of £11,849 10s. 6d. has been expended on account of capital expenditure. The revenue account shows a gross revenue of £3,408 14s. 10d., and a credit balance of £1,051 5s. 7d., after payment of all charges, including a proportion of the preliminary and formation expenses. The dividends on the 6 per cent. preference shares, due October 31st, 1885, and April 30th, 1886, have been paid.

Every effort has been made to push forward the business of this company since its district was taken over from the United Telephone Company, with a result as shown by the following statement:—

	Exchange Subscribers.	Private Line Renters.
February 1st, 1885 ...	116	123
April 30th, 1886 ...	687	248
Increase	571	125

In addition to the Telephone Exchanges at Brighton, Norwich, and Ipswich, handed over to this company by the United Telephone Company, exchanges have since been established at the following places, and further extensions will be made as the business develops:—Bedford, Cambridge, Chatham, Eastbourne, Folkestone, Gravesend, Great Yarmouth, Hastings and St. Leonards, King's Lynn, Luton, Maidstone, Northampton, Oxford, Peterborough, Reading.

It is with extreme regret the directors have to announce the death of the late chairman, Mr. Robinson Kendal, on March 13th last. The vacant seat on the board has been filled by the election of Mr. Alexander MacGregor, of 3, Collingham Gardens, London, S.W., and Mr. David Owen Bateson has been elected chairman.

The Cuba Submarine Telegraph Company, Limited.

THE report of the directors is as follows:—The directors beg to submit, duly audited, the balance sheet and accounts for the half year ended 30th June last.

From these it will be seen that the gross receipts (including the balance brought from last account) amount to £20,150 17s. 4d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs), to £10,148 19s. 8d., leaving a sum of £10,001 17s. 8d. to the credit of revenue account.

After providing for the preference dividend, a balance of £7,001 17s. 8d. remains, out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, which will absorb £6,400, and leave £601 17s. 8d. to be carried forward to the current half year's account.

The Batabano-Cienfuegos (original) cable broke down on 28th March, and was repaired on 25th May. This cable not being duplicated, messages were forwarded during the interruption over the land lines of the Government.

The repair was effected by Mr. Keith, the company's engineer, who has also during the half year laid a new harbour length at Santiago to replace one worn out.

With regard to the proposed cable between Halifax (Nova Scotia), Bermuda, and Jamaica, referred to in last report, the shareholders will be glad to learn that the British Government have decided not to lay a cable from Bermuda to Jamaica, but only from Halifax to Bermuda, thus avoiding the injury which this company would have sustained had the project been carried out in its entirety.

The Direct Spanish Telegraph Company, Limited.

SIR James Anderson has addressed the following to the shareholders of this company:—The examination of the original Bilbao cable, which was promised at the last general meeting of the company, has now been made, and the result is to show that it will be cheaper to abandon it than to repair and relay it. Overleaf is a copy of the report made to the board by the engineers, Messrs. Clark, Forde, and Taylor.

The directors, assisted by the best legal advice they can obtain, are giving their careful consideration to the position of the company, and the necessity of a reorganisation of its capital, with a view of determining the course which seems most practicable and best calculated to restore the company to a sounder condition; and they trust to be able to submit a definite scheme to the shareholders at the general meeting next September.

The report of Messrs. Clarke, Forde, and Taylor, is to the following effect:—As the result of the expeditions of the ss. *John Pender* and ss. *Volta*, which have recently been employed in investigating the condition of part of the above-named cable, and in picking up the remainder, we beg to state that we have formed the opinion that this line could not be advantageously restored. A large quantity of new cable would be required to re-establish the line, which, when completed, would be likely to break down again in a short time. We are of opinion that the only prudent course would be to lay an entirely new cable, which should either be constructed of a much heavier type, or be laid over quite a different track.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of July was 3,411, estimated to produce £2,800, against 3,038 messages, producing £2,517 in the corresponding month of last year. The receipts for the month of April, estimated at £3,300, realised £3,349.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st July are £2,376, as compared with £2,602 in the corresponding period of 1885. The April receipts, estimated at £5,762, realised £5,699.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 30th were £2,037, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July, 1886, were £1,270 against £1,284 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for July amounted to £34,931 against £46,099 in the corresponding period of 1885.

The Eastern Telegraph Company, Limited. The receipts for July amounted to £43,708, against £48,081 for the corresponding period of 1885.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending July 31st, were £3,050.

The Brazilian Submarine Telegraph Company Limited. The receipts for the week ending July 30th were £2,461.

NEW PATENTS—1886.

9757. "Electric meters." S. PITT. (Communicated by J. J. A. Aubert.) Dated July 28. (*Complete.*)

9769. "Regulating distance between carbons of electric arc lamps." G. A. GRINDLE. Dated July 29.

9770. "Treating or making electrotypes for printing." A. F. WENGER. Dated July 29.

9793. "Glass globes or shades and holders for incandescent lamps." H. LEA. Dated July 29.

9805. "Carbonising filaments for incandescent electric lamps." W. MAXWELL. Dated July 29.

9811. "Dynamo-electric machines." F. E. ELMORE. Dated July 29.

9817. "Protecting and running electric light or other leads." W. C. MOUNTAIN. Dated July 30.

9835. "Primary batteries of the manganese or Leclanché type." O. MARCH. Dated July 30.

9846. "Transmitting instruments for submarine and other long-distance telegraph lines." A. M. CLARK. (Communicated by L. Maiche.) Dated July 30.

9853. "Electricity conductors for telegraphic and other uses." E. FOX. Dated July 30.

9854. "Telephonic apparatus." D. BOYD, S. WILLIAMS. Dated July 30.

9873. "Induction coils." W. J. MULLER. Dated July 31.

9959. "Electrical firing keys or contact makers." C. A. McEVOY. Dated August 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

8622. "Improvements in electrical communications between door knockers, letter boxes, and bells. R. A. LEE. Dated July 16. 8d. Claims:—1. An electrical contact maker in conjunction with a knocker. 2. Fixing an insulated spring arrangement in the stud of a knocker. 3. Making connection between a knocker and one wire of an electric bell, and making connection between the stud of the knocker and the second wire of an electric bell. 4. Making connection between the knocker and an electric push through a spring or a lever either fixed to or forming part of the knocker. 5. An electric contact maker between a knocker and a bell whether used on a door or in connection with any other signalling apparatus. 6. The general combination substantially as described.

8744. "Improvements in apparatus or means for controlling the passage of electric currents in telephonic or other electric circuits." J. H. JOHNSON. (Communicated from abroad by La Société P. Barbier et Cie., of Paris.) Dated July 20. 8d. Claims:—1. In combination with a telephonic or other like electric circuit a current interrupter or intercepter such as a secondary battery so arranged as to render the telephones, bells or other local apparatus practically inaccessible to the currents of low tension from the main battery, but not to interfere with the passage of the telephonic, signalling or other currents whose tension is greater than that of the intercepter, all substantially as described and illustrated. 2. In combination with a telephonic or other like electric circuit, a primary battery placed in opposition to the main line battery or generator for the purpose of intercepting the low tension currents from the latter substantially as described and illustrated.

8747. "Improvements in machines for generating electromotive power." A. I. GRAVIER. Dated July 20. 8d. Claims:—1. The employment of symmetrical or unsymmetrical polar extensions so arranged that the distance between their extremities shall be equal to their extent, as explained. 2. The employment, in armatures of electric generators, of cores formed of iron wire, or of discs of sheet iron, of a sectional area equal or superior to that of the field magnets, as described.

9274. "Improvements in telephonic transmitters." R. H. RIDOUT. Dated August 4. 8d. The inventor supports on a suitable frame two electrically insulated conductors preferably of hard carbon, each in connection with a pole of an electric battery, and he electrically connects them by means of two or more transverse conductors preferably of hard carbon. The transverse pieces may be of any suitable shape, but it is preferred to construct and arrange them in such manner that collectively they may present a suitable surface to receive acoustic impulses. To complete the transmitter, he places the parts thereof as above described in a suitable case having a screen or damper of muslin, felt, cloth, wire, gauze, perforated sheet or other suitable material fixed between the transverse pieces and the source of sound, or he wholly or partially immerses them in a vessel of liquid, when he directs the sound upon the surface of such liquid. The claims are four in number.

9522. "Improvements in electrical accumulators or storage batteries." C. P. ELIESON. Dated August 10. 8d. Claims:—1. An electrical accumulator or storage battery such as is described, formed by placing spirals of sheet lead whose surfaces are separated by suitable insulating and acid proof material in suitable leaden or other frames or holders substantially as described. 2. The manufacture and use of the improved electrical accumulator or storage battery constructed substantially as described and illustrated in the drawing.

9526. "Improvements in and relating to electro-dynamic motors." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated August 10. 8d. Relates mainly to a mode of constructing electro-dynamic motors by which the necessity of shifting the commutator brushes upon the commutator cylinder when the armature current varies, to avoid spark, is obviated. Claims:—1. An electro-dynamic motor having differential field magnet coils and cumulative field magnet coils both in series with the armature, and main field magnet coils shunted upon the armature alone or upon the armature and either or both of the said sets of series coils, substantially as described. 2. In an electro-dynamic motor, the combination with the armature and main field magnet coils in shunt relation with the armature, of differential field magnet coils and cumulative field magnet coils both in series with the armature, the said differential coils being arranged to produce their greatest effect on diagonally opposite parts of the magnetic field, and the said cumulative coils arranged to produce their greatest effect on other diagonally opposite parts of the magnetic field, substantially as described.

9580. "Improvements in the preparation and production of insulating compounds for electrical purposes." A. MUIRHEAD and C. R. A. WRIGHT. Dated August 12. 6d. Claims:—1. The method described of solidifying castor or other suitable oil so as to obtain products of varying consistence as required, cartilaginous or plastic, by treating the oil with zinc chloride or other salt exerting a similar dehydrating and polymerising action upon oils, substantially as described. 2. The preparation of solidified oils containing in intimate admixture or chemical combination sulphur by dissolving in or mixing with the oil previous to solidification the requisite amount of that element, substantially as described. 3. The use of oils solidified as described, either alone or in conjunction with sulphur, as ingredients in mixtures intended as substitutes for gutta percha as insulating materials and for other purposes, and more especially in connection with gutta percha or India rubber, or vulcanised or "oxidised" oils, or resinous or bituminous substances, or with vulcanised gutta percha or India rubber, or with mixtures of such bodies, with or without the addition of mineral matters. 4. The treatment of oils solidified as described or by means of chloride of sulphur, with bi-sulphide of carbon, benzole, benzoline, or other solvents capable of dissolving ordinary unsolidified oil or admixed resinous matters, but not of dissolving solidified or sulphurised oil, for the purpose of purifying the products obtained substantially as described.

9896. "An improved galvanic element or battery." H. J. HADDAN. (Communicated from abroad by K. Pollak and G. Wehr, both of Berlin.) Dated August 20. 8d. The present invention relates to a galvanic element, in which the depolarising substances are always regenerated. For this purpose the inventor uses zinc and "metal" elements, for instance, zinc and copper, and sets the "metal," that is to say, in the case of a zinc-copper element, the copper, in conducting connection with carbon, which only partly dips into the exciting liquid, which liquid will be different according to the nature of the element. Claims:—1. In an element with two metallic electrodes the combination of porous carbon in electric connection with the positive electrode, for changing by local action the positive electrode partly into depolarising salts when the circuit of the element is not closed, from out of which salts, when the circuit is closed the metal of the positive electrode utilised for their generation is again precipitated upon the positive electrode. 2. The porous carbon for use in the element made from small pieces of carbon and carbon dust by pressing and baking in the shape of plates or blocks, forming compact and good conductors of electricity, which plates may or may not be provided with perforations.

9903. "Improvements in and relating to electric targets." G. ARNOULT. Dated August 20. 8d. Relates to electric targets, and is designed to provide improved means whereby, when any section of the target is struck by a bullet, one or more electric impulses will be transmitted to a receiver or indicator, the hand or pointer of which is capable of a step-by-step movement. Claims:—First. In an electric target wherein movable bolts or keys are arranged to receive the impact of the bullets, and to operate devices for transmitting electric impulses to a receiver or indicator, the provision of means (substantially as set forth) whereby the electric impulses for all the divisions or sections of the target can be transmitted to the receiver or indicator by the use of only two line wires, or of a single line wire and the earth. Second. The movable ribs or bars for covering the joints between the said bolts or keys and the plate in which they are fitted, and for directing the bullets towards the said bolts or keys, substantially as and for the purposes set forth. Third. The device for opening and closing the electric circuit, comprising the roller arranged to move upward over the lever or switch, and to roll down beneath the same with one end of its axle upon a toothed or serrated surface, substantially as and for the purpose set forth. Fourth. The sliding frame carrying the device for opening and closing the electric circuit and provided with the springs or plates adapted to make contact with plates or terminals in the target, substantially as and for the purpose set forth. Fifth. The improved electric target consisting of the parts constructed and combined, substantially as described with reference to the drawing and operating, as and for the purpose specified.

9962. "Improved system of telephones." A. M. ROSEBRUGH. Dated August 22. 8d. Claims:—First. In a mechanical telephone exchange system the use of a line or conveyor of air waves composed throughout the whole or part of its length of cord or of tubes or both with which is wound or combined thin wire or wires or the equivalent thereof to make metallic continuity between the telephones, substantially as and for the purpose described. Second. In mechanical telephones the interposition of an elastic or yielding cushion or packing between the diaphragm and the part in or on which it is mounted or by which it is covered, substantially as and for the purpose described. Third. In mechanical telephones a tube or elbow pipe provided with diaphragms to which the line is attached so that the air in the tube acts as a conveyor of sound from one portion to another of the line or system, substantially as and for the purpose described. Fourth. In mechanical telephones a tube or hollow conveyor attachable to the mouthpieces or tubes leading from one subscriber's line to another through the exchange or the like substantially as described and for the purpose of conveying the air vibrations from any one line into the exchange and out therefrom along any other line as required. Fifth. The several arrangements or combinations of parts described and illustrated in the several figures of the drawings.

10011. "Improvements in compound galvanic batteries and in the method of working the same." S. H. EMMENS. Dated August 24. 4d. The inventor employs as the electrodes of each cell one or more peroxidised lead plates, and one or more plates of zinc or any other metal that is electro-positive to such peroxidised lead plates. The lead plates are mounted in frames or otherwise made easily removable, so that when exhausted of their available oxygen they may be readily changed for fresh plates, and the action of the battery thus maintained for any length of time. The electrolyte is preferably composed of dilute sulphuric acid, but may be any suitable saline solution, and can be drawn off wholly or in part and renewed as required. Claims:—1. The construction and combination of removable secondary electrodes in primary cells, substantially as specified. 2. The further combination therewith of a charging bath, substantially as specified.

10122. "An electric meter or current registering instrument." F. F. YEATMAN. Dated August 26. 8d. This electric meter, or current registering instrument, consists essentially of two discs, preferably of copper, cast upon opposite ends of the same hollow shaft or tube, also preferably of copper; one of these discs being considerably larger than the other. These two discs are so placed with regard to two metal troughs, that the lower part of the periphery of one disc is within one of the metal troughs, and the lower part of the other disc within the other trough. The two troughs are to contain sufficient mercury to form electrical contacts between each trough and its disc. On either side of the larger disc is placed a magnetic pole. When a current of electricity is caused to pass from one trough to the other by way of the discs and their connecting shafts, the discs will be caused to revolve, and the speed of their revolution will depend upon the strength of this current and also upon the strength of the magnetic field in which the larger disc is placed. Claims:—1. The improved arrangement and construction of an electrical meter or current registering instrument, substantially as described and illustrated by the drawings. 2. The use and application in an electrical meter or current registering instrument of metal discs in conjunction with troughs containing mercury as and for the purpose described and represented in the drawings.

10126. "Improvements in telephone transmitters." R. PRYOR. (Communicated from abroad by Messrs. Miles & Co., of Christchurch, New Zealand.) Dated August 26. 8d. Claims:—1. The use of any mineral ore in its natural state or any artificial imitation of which any part or parts or any mineral ore may form its component part or parts in the use of and for the purpose of forming a telephone transmitter, which transmitter may be constructed as follows:—A plate or button suspended by means of spring or springs or elastic substance in connection with one or more plates or pencils or buttons or knobs or surfaces, the plate or button forming an electrode, the pencils or buttons, &c., the other, or the pencils or buttons, &c., forming separate electrodes, the plate or button collecting and transmitting the current from one to the other. The plate or button is made of mineral ore, preferably of chalcopyrite, the pencil or pencils or buttons, &c., of metal, or *vice versa*, or both plate or button and pencil or pencils or buttons, &c., of mineral ore only, thus dispensing with the use of permanent or electro-magnets, carbon in various forms, diaphragms and induction coils. 2. The use in telephone transmitters of chalcopyrite, substantially as described.

10231. "An improved telephonic transmitter." C. D. ABEL. (Communicated from abroad by La Societé Generale des Téléphones of Paris.) Dated August 28. 8d. Claims:—1. The use in combination with the diaphragm of two contacts attached thereto, each of which is connected to a separate conducting wire, and a wedge contact interposed between these and so arranged as to oppose by inertia the vibrations imparted to the other two contacts by the diaphragm substantially as and for the purposes described. 2. Connecting the wedge contact referred to in the preceding claim to a suspended mass or to springs, or equivalent devices for affording it the requisite inertia, substantially as described. 3. Connecting the wires of the two diaphragm contacts referred to in the first claim, each to one end of two primary coils of an induction apparatus, the other ends of which coils are connected to a single wire leading to the one pole of the battery, whose other pole is connected to the wedge contact, so that the induced current sent into the line is produced in the secondary coil by the differential action of the two currents in the primary coils, resulting from the combined action of the two diaphragm contacts and the wedge contact.

10370. "Improvements in electric telephony." J. G. LORRAIN. Dated September 1. 8d. The inventor employs an instrument consisting essentially of two conductors arranged in proximity and suitably disposed with regard to one another, and of a moveable screen of suitable material so arranged and disposed with respect to the said conductors that when the instrument is acting as a transmitter the said screen may vibrate, under the influence of sound waves, in such manner that the inductive influence of the one conductor upon the other may vary with such vibrations, and when the instrument is acting as a receiver the said screen may vibrate under the influence of the variations of current in such manner as to produce sound waves or air pulsations. Claims:—1. The improvement in electric telephony, consisting of the transmitting instrument, substantially as set forth. 2. The improvement in electric telephony, consisting of the receiving instrument, substantially as set forth. 3. In a telephone transmitter the combination of two conductors and a screen either with or without a diaphragm, and either with or without an intensifier arranged and acting substantially as set forth. 4. In a telephone receiver the combination of two conductors and a screen either with or without a diaphragm, and either with or without an intensifier arranged and acting substantially as set forth.

10538. "Gas burner with electric ignition." F. GIRAUD and E. NEE. Dated September 5. 8d. Claims:—1. Lighting a gas burner by means of an electric spark generated above the burner at the moment of rupture of contact between a rigid rod, situated on the plug or cock of the gas burner, and connected to one pole of an electric generator, and a flexible plate or spring situated on the socket of the burner and connected to the other pole of the said generator by a coil of insulated wire inserted in the electrical circuit, substantially as described. 2. Lighting a gas burner by means of an electric spark generated above a supplementary burner, but below the main burner, at the moment of rupture of contact between a rigid rod situated on the plug or cock of the gas burner, and connected to one pole of an electric generator, and a flexible plate or spring situated on the socket of the burner and connected to the other pole of the said generator by a coil of insulated wire inserted in the circuit, the electric spark lighting the supplementary burner, which in turn lights the main burner, substantially as described.

CORRESPONDENCE.

Primary Batteries.

If it concerned myself alone I should only thank the electricians, who, after 28 years, have been good enough to pay attention to the communications which Doctor Humbert and myself addressed to the Academy of Sciences at its meeting of March, 1858. But my friend, Doctor Humbert, having died in 1860 from consumption, the development of which our experiments with the chlorine gas hastened, if they did not produce it, I cannot leave without rectification the letter of M. Dierman, published in your number of the 9th July. In consequence, I beg you to be good enough to publish my reclamations in your next number.

The chlorine primary battery has not been abandoned by its authors, as said M. Dierman, but we have studied it with very great care. In a *Memoire* which is in the archives of the Academy of Sciences, we have described all the very curious phenomena observed by us.

This society, with as usual very little regard for young inventors who were renouncing the pecuniary advantages of their invention, has published in its *Comptes Rendus* only an extract, ridiculously abbreviated and badly treated by an unintelligent critic. The commission before which we have several times performed our experiments did not condescend to make a report. It is the rule, and for that reason we did not complain.

We have as a retaliation published in some numbers of *Le Temps*, the most important points demonstrated by us.

Doctor Humbert died convinced that he had sacrificed his health, and perhaps his life, to an important question to which justice would be done later on. Since then I have let matters take their own course, because I was curious to see how long our pearls would lie before being picked up. This primary battery gives a very constant current, and M. Niaudet Breguet does

not exagerate in the eulogies he has bestowed upon it. If M. W. Dierman could not obtain good results, it is because he did not follow the instructions given by us in 1858.

I take the liberty to add that from my point of view the use of the porous pot is a great fault as introducing a useless resistance. I think the cell susceptible of great improvements, but these are not be found in the way in which Messrs. Dierman and Upward are now travelling.

I beg you to excuse me for not giving further particulars about this point, for people are so little accustomed to the disinterestedness of the inventors that they may believe that I find my idea of no use and therefore accuse me of abandoning it.

W. de Fonvielle.

Paris, *July 30th*, 1886.

The Watt and the Joule.

I notice in your correspondence columns the expression, "number of foot-pounds in a watt." It should be, "in a watt-second or *joule*." (The number is ·737.) I need not say more, as you reproduced some months ago a somewhat more lengthy correction of the same very common mistake.

Desmond G. FitzGerald.

Work Performed in Telegraphing.

In my last letter I should, of course, have said 1·355 is the number of watts in a foot-pound, instead of *vice versâ*. The constant has been correctly used, as the context of my letter should have convinced "Ita." It is needless to trespass upon the pages of this journal to explain the matter more fully than I have already done.

W. Moon.

The Edison and Swan Meeting.

Those who have had the good luck to hold shares in any company in which Mr. Forbes has been steersman at the helm, well know what an expert and experienced chairman he makes, and what a happy knack he has of guiding his flock. What other man in the world, in the face of such facts, could have got over the difficulty in meeting a body of shareholders with the enormous profit of £24 5s. 6d. made on a year's trading upon a capital of £300,000? For this act alone he well deserves his fees.

One thing the report clearly shows, although to be regretted, that the trade in the Edison and Swan lamps is undoubtedly falling off to an alarming extent, and this even in the face of an enormous increase in the output of dynamo machines and batteries, besides the extra consumption of lamps being used at the exhibitions. To my mind this great falling off is *not due to*, or traceable to, the actions of the Board of Trade, but is clearly due to one simple fact that there are better and cheaper lamps in the market than those sold by the company, which the private consumer when it touches his own pocket is never slow to find out, as they apparently have done, to a large extent during the past year.

I may say I fully endorse your remarks that it would be better for the company to use its endeavours if possible to make a lamp which would require less consumption of energy to obtain its full C.P. of incandescence. Now, if the company did this, there would be no need to trouble about alleged infringements (which is only another word for food for the lawyers), as the company would then command the bulk of the trade, which they will never get by annoying consumers in the manner they are now doing.

A little healthy competition, as a rule, does no harm, but rather helps to increase the demand. A monopoly in the sale of lamps could do no good, and only tend to make a rod for the company's own back by checking an important industry just now on the turning point of success. Unfortunately, the Edison and Swan lamps, although well suited for central station lighting by Edison machines, are not adapted to run in combination with so many other machines in the market; and, worse still (owing to their high E.M.F.), for users of small battery lamps for domestic purposes.

I am glad to see that the Brush Company, and Messrs. Shippey Brothers and others, intend to frustrate, if possible, a monopoly of the incandescent lamp trade, which would be a death blow to electrical engineering if secured by the company, as it would mean Edison lamps, Edison dynamos, to a very great extent. In the meantime, until this question is decided, the gas companies are grinning because another check is likely to be given to the advancement of the electric light, and their dog in the manger policy will not gain them friends. Under these circumstances, it is not to be wondered that so many shareholders besides Mr. Prior are becoming uneasy, and heartily wish they could land their shares on someone else, and rid themselves from the liability of future calls. And, before parting with more money, the shareholders would do well to ponder over the probable amount of costs likely to be incurred in fighting an action with so powerful a company as the Brush Corporation, who, it appears, are owners of incandescent lamps, the patents bearing date prior to those of the Edison and Swan Company; and, in the long run, who can tell but that Father Brush, who came over to sweep the way, may yet keep the path clear for consumers to use other lamps than those sold by the Edison and Swan Company.

John Bilton.

6, Stockwell Road, S.W.,
August 2nd, 1886.

The Upward Battery.

In your note on the Maquay battery you state your belief that local action will form an important part of its working. Practical experience shows that this is not so. The plates remain, after a long run, as bright and clean as when first started.

Re the Upward battery. A confirmation of my predictions is recorded in the columns of *The English Mechanic* of this week. A gentleman who had made himself an Upward battery states, that after he got it to work, an escape of chlorine took place, and that in spite of all precautions and of the apparatus being in an open shed outside the house, the operator himself was nearly choked, and the gas penetrated into the house, causing great inconvenience. I do not wish for a moment to compare the crude apparatus put together by an amateur with the apparatus that will doubtless be sent out by the makers; but the incident is instructive nevertheless. In reply to Mr. Crawley, as I observe in his letter which is printed in your current impression that he has practically given up the point at issue, *re* the chemical reaction within the battery, I hardly see the necessity of carrying the correspondence any further. Messrs. Crawley and Upward stated very emphatically that my account of the actions within the battery was totally incorrect; and further, that no hydrochloric acid could be formed in the manner I suggested, viz., by the combination of the nascent hydrogen with the chlorine, for the simple reason that there was no hydrogen gas there to enter into combination. He now states that they have found some H Cl, but not as much as they expected. Bearing in mind the diminished bulk of H Cl as against that taken up by its components when free, and the capacity of the carbon for absorbing liquids, I do not think this is surprising. As, also, it is difficult to see where the H Cl could come from except in the manner I suggested, I think we may fairly consider the matter settled; and with this I beg to close the correspondence so far as I am concerned.

alker.

Cardiff, *August 2nd*, 1886.

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